Environmental Resources Management

1001 SW 5th Avenue,
Suite 1010
Portland, Oregon 97204
T: 503-488-5282
F: 503-488-5142

September 24, 2015
Project No. 0283866

Erin McDonnell, P.E.
Cleanup Project Manager
Northwest Region Cleanup Program
Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, OR 97232

RE: Premier Edible Oils Site
Responses to DEQ/USEPA Comments on Basis of Design Report - Groundwater Source Control Measure

Dear Erin:

This letter, prepared by ERM-West, Inc. on behalf of MMGL Corporation (MMGL), provides responses to comments received from the Oregon Department of Environmental Quality (DEQ) and United States Environmental Protection Agency (EPA) in a letter dated August 28, 2015, related to the *Basis of Design Report - Groundwater Source Control Measure* (BOD), dated July 2015 for the Premier Edible Oil (PEO) site located at 10400 N. Burgard Way, Portland, Oregon.

The proposed groundwater source control measure (GW SCM) consists of a groundwater barrier wall (GWBW) and oxygenation/biobarrier system; however, responses to comments are focused on the imminent implementation of the GWBW, scheduled for construction in Fall 2015. Each of the DEQ/USEPA comments is provided below in italic font, followed by the MMGL response. A revised Basis of Design (BOD) Report will be submitted with the GWBW Final Design.

<u>DEQ COMMENTS</u>
General Comments

1. *Provide a simple communication plan or some other documentation to clarify lines of communication and contact information during work. Include who DEQ should address about making field corrections and/or stopping work if we observe activities not conducted as agreed. In addition, DEQ requests a weekly construction update covering activities (Monday-Friday) and weekly onsite meetings with DEQ during construction of the SCM.*

A *Communication Plan - Upland Source Control Measures* is included as Attachment A.

2. *A great deal of construction detail rely on a not yet identified "Contractor" including technique, slurry mix, materials management, quality control, etc. DEQ requests submittal for review and approval these additional specifications to be determined by the Contractor prior to implementation including:*

   a. *The Groundwater Barrier Wall Work Plan referenced in the technical specifications Division 2 – Site Work 1.09 (C) Submittals, page 02242-8.*
   b. *Work plans also referenced in Site Work 1.05 (A) Submittals, page 02200-3 for excavation, separation of materials, construction of slurry pond, staging, etc.*
   c. *The Construction Quality Assurance/ Quality Control (CQA/QC) referenced (e.g. 01010-4 and 02242-1). If different than the CQA/QC, also provide the final Quality Control Plan referenced in Site Work 1.09 (D) Quality Control Plan, page 02242-9 for DEQ review and approval.*
   d. *Provide copies of all Health and Safety Plans (HASPs) developed by ERM or subcontractor.*

Following a contractor selection process, DeWind One-Pass Trenching, LLC (DeWind) is in the process of being retained for the installation of the GWBW. The selected contractor (DeWind) will use One-Pass Trenching Technology for the construction of GWBW which uses a specialized equipment with a large cutting chain/trencher (i.e., resembles a large chainsaw) to cut the trench and mix the existing soils with bentonite simultaneously. This method uses in-situ trenching and homogenizing the in-place soil while simultaneously adding prescribed bentonite and water to form the soil-bentonite mixture. During installation, the cutting chain will start cutting the trench at either end of the alignment until the trencher is in vertical position. Once the trencher is in vertical position, dry bentonite will be added through a bentonite delivery system down a tube attached to the cutting chain into the soil below grade. The chain of the trencher will simultaneously homogenize the soil and dry bentonite to the required depth. The depth is controlled by laser level guided receiver of the OPT. Water will also be added through a water line into the cutting chain below grade. These steps happen simultaneously and continuously throughout the GWBW installation. Thus, this method eliminates many steps of conventional slurry wall construction such as using bentonite slurry, construction of slurry pond, QC testing on bentonite slurry. However, contractor prepared documents referenced in this comment will not be available for review prior to the contract execution date. Given the proximity to the tentative project start date, it is likely there will be insufficient time for DEQ review and comment on the work plan. It should be noted that the contractor is required to submit the documents to the project Engineer (ERM) who will review the submittal. Where possible, the documents will be provided to the DEQ; however, work will not be delayed for further comment.

   a. DeWind will prepare a work plan to describe the proposed GWBW construction methodology utilizing the One-Pass Trenching Technology, procedures, equipment, and schedules.

b. DeWind will prepare a work plan to propose methods of excavation and separation of materials. Note that some of the specific construction elements may not be required (e.g., the One-Pass Trenching Technology mixes the backfill slurry in-situ and does not require a mixing pond).
c. The draft Construction Quality Assurance/Quality Control Plan (CQA/QC) is included as Attachment B. The selected contractor will be required to document their compliance with this CQA/QC plan to the project Engineer including details of the personnel, responsibilities, inspections, and organization for ensuring the quality of construction required by the specifications. The results of quality control testing will be presented in a Construction Completion Report.
d. The ERM-developed HASP is included as Attachment C. The DeWind HASP will be prepared and submitted to DEQ as information. Should any major deficiencies be identified in either HASP, ERM and MMGL will discuss these with ODEQ and work to address them as expeditiously as possible. It should be noted that the HASP maintained on site will be a 'living' document and may be updated as required based on specific factors and issues observed on-site, and during project kick-off meeting, and daily meetings.

3. Project design drawings are appropriately stamped by an Oregon Professional Engineer (Brendan Robinson, P.E.). Interpretations provided regarding the geotechnical/slope stability analysis performed and recommended setback for the "slurry-based" barrier wall presented in the memorandum, Groundwater Barrier Wall Conceptual Design and Setback, dated May 4, 2015, also requires endorsement by an Oregon Professional Engineer. Enclose this technical memorandum as an appendix to the Final (100%) Design document.

The *Groundwater Barrier Wall Conceptual Design and Setback, dated May 4, 2015,* stamped by Erik Ipsen, P.E. is included in Attachment D.

Specific Comments

1. *Section 1.1.1 Site History. This section suggests a potential oxygenation system but the remainder of the report states designs plans will be provided in the future with the performance monitoring plan. Please clarify your intentions related to oxygenation in conjunction with the GWBW. While the barrier wall should increase travel time of impacted groundwater to the river, if aquifer geochemistry does not shift from primarily reducing to oxidizing conditions metals may persist in the dissolved phase. Therefore, DEQ supports the introduction of oxygen in the LNAPL area to promote redox conditions favorable to degrade and/or stabilize COCs in groundwater.*

An oxygenation/biobarrier system has been proposed as a second phase of the GW SCM. The purpose of the oxygenation/biobarrier system is to introduce oxygen into the subsurface to increase biological degradation of the dissolved TPH and to re-oxidize the As and Mn, causing them to form insoluble metal hydroxides and become immobilized. As noted in the BOD, the selection of the oxygenation/biobarrier system includes future technology selection (including pilot study) and system design (including final performance monitoring plan) followed by construction and implementation.

2. *Section 2.2.1, Site Soils. The stratigraphic profile shown in Appendix A, Sheet 5, is general and shows no heterogeneity. In the following paragraph, expand upon how native soils will be considered within construction and slurry mixing activities.*

The stratigraphic profile represents conditions observed during recent investigations as presented in the *Groundwater Barrier Wall Conceptual Design and Setback, dated May 4, 2015,* as well as generalized historical investigations and observations at the site. A compatibility study was undertaken to support the conceptual design of the SCM beginning in May 2015 and included the collection of bulk soil samples (representative of lateral and vertical stratigraphy and collected from areas of known soil and groundwater contamination), groundwater samples, and site "mix water." These samples were submitted to a geotechnical laboratory for compatibility testing. Available compatibility test data and boring logs were provided to contract bidders for consideration and the selected bentonite percentage by the contractor utilizes knowledge of the existing fines in site soils. Further, the QA/QC process requires the contractor to meet a maximum permeability specification of the GWBW of 1×10^{-6} centimeters per second (cm/sec), regardless of native soil characteristics.

3. *Section 2.2.2, Extent of Groundwater Impacts. Speak to the purpose of transition zone water (TZW) sampling related to the project and results. It would also be helpful to show extent of As and Mn in groundwater above acceptable levels relative to placement of the GWBW and oxygenation system.*

Low river stage TZW sampling was conducted in September 2014 and high river stage TZW sampling was conducted in May 2015. The purpose of the TZW sampling program was to evaluate potential shallow impacts to TZW and to assist in remedial design of the GW SCMs. Results of the TZW sampling program indicated that LNAPL only extends a short distance beyond the top of bank and does not reach the TZW. The high stage TZW event used a less disruptive sampling technique and focused on characterizing the hyporheic zone. Concentrations of total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylenes (BTEX compounds) were lower in the high stage TZW samples. Additionally, Mn concentrations were lower in the most recent event and As concentrations in both TZW sampling events were below 10 micrograms per liter (µg/L). Concentrations observed indicate that dissolved impacts to the TZW are limited, even under current conditions.

Preliminary results of the TZW sampling were used to evaluate the length of the GWBW which was subsequently extended to 453 feet based on concentrations of benzene observed in TZW-10 (0.89 µg/L) near the southeast proximity of the GWBW alignment.

4. *Section 2.3, Groundwater Source Control Measure Summary. The purpose of the GWBW is to prevent migration of LNAPL and dissolved phased TPH to the river by the means of increasing travel time of impacted groundwater. Expand on this concept and other design objectives, such as diminished contribution to the "stranded wedge" and improved overall water quality.*

The purpose the GW SCM, including the first phase of the GWBW and the second phase of the proposed oxygenation/biobarrier system, is to control the potential migration of LNAPL into TZW and mitigate dissolved phase metal contaminant impacts to the Willamette River. The primary objective of the GWBW is to control potential migration of LNAPL. The primary objective of the future oxygenation/biobarrier system is to introduce oxygen into the subsurface to promote further biological degradation of the LNAPL and dissolved phase impacts and to re-oxidize the As and Mn, causing them to become less mobile. The BOD report will be revised and resubmitted to clarify these objectives.

The installation of a GWBW is expected to significantly reduce the flux of contaminants from the uplands portion of the site. Following installation of the GWBW, the hydraulic gradient on the riverward side of the barrier wall is expected to flatten, thereby significantly reducing mass flux from the "stranded wedge" and improving overall TZW water quality.

A byproduct of GWBW installation is the increased travel time of groundwater flow which will allow for greater treatment time on the upgradient side of the GWBW following implementation of the oxygenation/biobarrier phase of the GW SCM. The flow of oxygenated water under and around the GWBW is expected to increase the current ongoing natural attenuation.

5. *Section 2.4.2, Construction Technique. Various slurry wall construction options and their effect on the wall alignment are presented in the Conceptual Design memorandum. Is there a preferred/expected technique to present? The chosen method should be described in sufficient detail and communicated to DEQ prior to construction.*

Please see response to DEQ General Comment #2 above regard construction technique.

6. *Section 2.4.3, Backfill Mix Design.*
   a. Summarize requirements for hydraulic conductivity in-situ or reference technical specifications.
   b. Provide detail on the mix process. Is it anticipated that a slurry pond will be needed?
   c. Provide slurry compatibility and mix design testing results (Treatability Study Report) in the Final Design or construction completion report.

a. As required in Technical Specification 02242 –Groundwater Barrier Wall, the GWBW shall have a maximum in-situ permeability of 1 x 10-6 cm/sec.
b. Refer to response to DEQ general comment #2 for mixing process. There will be no slurry pond needed for the construction of GWBW based on the construction technique selected. Final Design Report will present the selected construction technique and methodology.
c. Compatibility testing on the design mix is still in progress. Laboratory trial mix design indicated that a 5% dry bentonite by moist soil weight was required to achieve a permeability value of 1 x 10-6 cm/sec. Thus, a mix of 5% dry bentonite and site soils were selected for compatibility testing using site's groundwater as a permeant. The initial compatibility test (first 54 days) indicates that the permeability of the presumptive design mix (5% dry bentonite by moist soil weight) is well below project requirements (maximum in-situ permeability of 1 x 10-6 cm/sec), and is further decreasing with time. This indicates that the design mix will exceed the project specification (maximum in-situ permeability of 1 x 10-6 cm/sec). The initial compatibility test report (first 54 days) along with laboratory trial mix design is presented in Attachment E. The complete final treatability study report will be presented to the ODEQ in the Construction Completion Report.

7. *Section 2.4.4, Wall Alignment. As noted above, please include the Conceptual Design document in the Final Design.*

The Groundwater Barrier Wall Conceptual Design and Setback, dated May 4, 2015 is included in Attachment D.

8. *Section 2.4.5, Wall length and Depth. DEQ has been provided a basic summary of preliminary groundwater modeling and it was anticipated that further detail would be provided in the design report. Discuss modeling performed to evaluate predicted travel times for a given wall depth and how this played into the wall depth proposed. Also provide details on wall thickness and basis.*

The proposed GWBW consists of a bentonite slurry wall installed from ground surface down to 35 feet below ground surface and will be 30 inches thick.

A steady-state numerical groundwater model was constructed to simulate three wall depth scenarios. The results of the groundwater modeling were presented by

Treadwell & Rollo. The southwest model boundary was represented by the Willamette River at a constant river stage elevation. Simulations were run for a proposed wall 30 feet deep and with Willamette River at average stage, for a proposed wall of 40 feet deep and with Willamette River at average stage, and for a proposed wall of 40 feet deep and with Willamette River at maximum stage. Particle tracking results generally indicated groundwater would travel down and below the GWBW and that there was relatively insignificant difference between the travel time to the river between the 30 and 40 foot deep wall scenarios. Based on results of the modeling a 30 foot GWBW was proposed in the preliminary conceptual design, the *Groundwater Barrier Wall Conceptual Design and Setback Memorandum* (Conceptual Design) submitted to the ODEQ in May 2015 (ERM 2015). However, the depth of the GWBW was revised to 35 feet bgs during the draft design, as fine sand and silt layers are generally observed at approximately 35 feet bgs. Based on field observations, the vertical extent of LNAPL appears to be generally constrained by these silt layers.

The thickness of barrier wall is generally based on the feasibility of the equipment available. Traditional slurry wall construction is usually performed using a 30 or 36-inch wide excavator bucket. The minimum thickness of the GWBW will be 30 inches, as installed with the One-Pass trencher. The One-Pass Trenching is a more controlled process than traditional slurry wall installation and will allow for a homogenous mix of the in-place soils and prescribed bentonite and water. DeWind is proposing to use a higher percentage of bentonite in the mix. This conservative approach is anticipated to result in a GWBW with permeability lower than the design hydraulic conductivity of 1x10-6 cm/sec.

9. *Section 3.0, Groundwater Barrier Wall Construction Permitting. DEQ does have the authority during a cleanup action to waive administrative requirements related to state and local government permits; however, as noted substantive requirements must be satisfied. For the project identify all permits you are considering not obtaining and work with DEQ to ensure substantive requirements are met.*

A National Pollutant Discharge Elimination System General Construction Storm Water Permit (1200-C) has been obtained for discharge of storm water during construction of the GWBW (File Number 124368).

In order to ensure that the substantive requirements of applicable local permits are met, an Exempt Review has been initiated with City of Portland. The exempt review process consists of review by the City of Portland Bureau of Development Services and Bureau of Environmental Services for compliance with applicable City codes and regulations, including greenway overlay zoning requirements. No additional permits have been identified for substantive requirements.

10. *Section 3.2, Local. Describe the City's substantive requirements and how PEO plans to fulfill these, such as plans for future plantings (e.g. habitat considerations and vegetation restoration).*

ERM submitted a *Greenway Exempt Review Submittal - Upland Source Control Measures Southern Premier Edible Oils (PEO) Site, Portland, Oregon* dated June 2015 and discussions with the City are ongoing. Although tree standards have been met, the City is evaluating potential additional revegetation requirements. MMGL has noted that the removal or remedial action area is limited to areas above top of bank and, as such, does not include river frontage. Thus, per Section 33.440.030.C regarding Greenway Overlay Zones, revegetation requirements are only applicable to the area of disturbance.

Section 4, Construction Management.
a. Planning emphasizes safe implementation and successful construction; however, unforeseen events can occur. Discuss additional contingency planning and response actions, specifically spills and/or stability failures related to the slurry.
b. Heavy equipment can compress soils and mobilize NAPL, potentially into adjacent waterways. DEQ recommends that MMGL have booms of sorbent material and /or other spill response equipment onsite that can be rapidly implemented and is capable of containing LNAPL releases to surface water.
c. *The DEQ project manager needs to be notified in the event of a spill (Site Work 3.01 (E) General, page 02250-4). If a spill occurs above a reportable quantity which is any amount that affects surface water, Oregon Emergency Response System (1.800.452.0311) must be notified per Oregon Administrative Rules (OAR) 340-142-0040.*

Comments noted. Discussion of contingency planning with DeWind began during the contractor procurement process. Measures will be taken to ensure that site materials (including NAPL) do not enter the watercourse. The One-Pass Trenching Technology does not require the excavation of an open trench supported by slurry, thereby eliminating the potential for a slurry release to the Willamette River.

The One-Pass Trenching equipment is smaller and lighter than traditional slurry wall excavation equipment. The anticipated duration of wall installation is two to three days, with the equipment moving relatively quickly. This will significantly reduce the potential for slope instability and LNAPL mobilization during construction. Further, the LNAPL present is degraded diesel and is considered relatively immobile, and therefore is unlikely to be affected by the equipment. Monitoring of the shoreline will be coordinated during wall installation activities and an emergency response organization will be listed in the work plan and ERM's and DeWind's HASPs.

Subsurface clearance procedures including one-call notification and geophysical utility locates (including ground penetrating radar) have been performed in the GWBW alignment area as part of the design and compatibility testing phases of the project.

Additionally, DeWind will coordinate a ground disturbance program as part of the HASP.

In the event an unknown utility is struck or there is potential loss of slope stability, it is anticipated that the soil-bentonite mix will stop without significant spread and loss of material during a potential a release due to the relatively thick soil-bentonite mix proposed by DeWind.

In the potential event of a release, further investigation will be performed to review and assess the situation and the OERS and DEQ will be informed. Please also reference ERM's Communication Plan in Attachment A.

11. *Section 4.2, Staging Area. The Work Area shown in Sheet 3 is considerably general. Provide additional details on staging of materials.*

Following the recent contractor selection, the Work Area in Sheet 3 is being updated as part of the Final Design. With the selection of the One-Pass Trenching Technology, slurry ponds and other features associated with traditional slurry wall installation techniques are not needed. It is anticipated that only three pieces of equipment will be in operation during the installation and that there will be no open excavations during installation.

12. *Section 4.3, Erosion/Sediment Control and Construction Stormwater Management. Provide a copy of the Erosion and Sediment Control Plan (ESCP) completed for the 1200-C stormwater permit with the Final Design or separate submittal. Given the nature of work and that contamination will be encountered, ESC measures should exceed typical construction projects. Also see comments below related to Sheet 4.*

The approved 1200-C permit is included in Attachment F.

Additionally, benefits of the One-Pass Trenching Technology include that the mixing is completed in-situ, eliminating the need for mixing ponds and reducing the amount of excavated spoils.

13. *Section 4.4, Quality Assurance/ Quality Control Activities.*
    a. DEQ may request more than two locations for GWBW QA/QC testing (Site Work 2.06 (A) General, page 02242-15 and Table 02242-1)
    b. Import fill material should be characterized to confirm it is "clean" and suitable for placement onsite. Results should be submitted to DEQ for review/approval prior to transport to the site.

a) The two locations for permeability testing as presented on Site Work 2.06A General, page 02242-15 and Table 02242-1 are for in-situ permeability testing on samples obtained by coring into the constructed GWBW. Making holes in already constructed GWBW should be minimized as it causes non-homogeneity of the GWBW wall and introduces potential for non-confirmability with the project specifications. A rigorous QA/QC for in-situ permeability testing will be performed during construction. During construction, samples of soil-reagent mix will be collected and molded for permeability (ASTM D5084) testing each time the batch plant begins operation and at minimum of every 2 hours during the installation of GWBW.

b) Comment noted. Where possible, analysis of the material from the supplier will be provided to the DEQ for evaluation. A minimum of one representative sample will be collected per 100 cubic yards of imported soil. It should be noted that the only imported fill anticipated is for the clay cap which is estimated for an in-place clay volume of 168 cubic yards and dense graded aggregate which is not considered as soil or suitable for testing. Maximum allowable concentrations will be provided in the CMMP.

14. *Section 4.5, Contaminated Materials Management.*
    a. In general, DEQ needs to review and approve characterization of waste generated onsite and appropriate disposal location. Document protocol in the contaminated media management plan (CMMP) or separate work plan.
    b. DEQ requires review/approval for stockpiling and staging plan for soils, trench spoils, and debris referenced in Site Work 1.05(B) Submittals, page 02200-4. Furthermore disposal facility considerations specified in Section 1.05 Disposal Facilities, Page 02250-3 also require DEQ approval.
    c. Document protocol for management of de-watering or un-used groundwater, characterization and proper disposal. Also see comments below related to the CMMP.

See revised CMMP as Attachment G.

15. *Section 5.2, Groundwater Sample Collection and Analysis. The sampling and analysis plan will need to be more comprehensive than that conceptually proposed. Semi-annual and groundwater samples for the first year followed by annual samples is an insufficient program to establish base line conditions, contaminant reduction trends related treatment, temporal variability and support evaluations that the system is working or adaptive management measures need to be evaluated and implemented. It is expected that quarterly monitoring will be performed, and with DEQ approval, semi-annual sometime in the future.*

Comment noted.

16. *Appendix A, Sheet 4/6. Show surface flow direction, proposed stockpile/staging areas, and all functional catch basins (including CB-16) and proposed controls to mitigate potential impacts from project activities.*

The design drawings are being updated as part of the Final Design; however, with the selection of the One-Pass Trenching Technology, slurry ponds and other features associated with traditional slurry wall installation techniques are not needed. It is anticipated that only three pieces of equipment will be in operation during the installation and that there will be no open excavations during installation.

17. Appendix B, CMMP.

a. Go into detail on stockpile/staging area locations.

b. Page 2. The "criteria" when employing PID instrumentation to determine soil or debris is contaminated with VOCs is not stated above. Updated report to include the criteria.

c. Page 3. Elaborate on protocol for determining the number of samples collected and required testing.

The revised CMMP is attached in Attachment G. However, as noted above, with the selection of DeWind's One-Pass Trenching technology, slurry ponds and other features associated with traditional slurry wall installation techniques are not needed. Spoils will not be re-used on-site. If required, the protocol for determining the number of samples collected and required testing will be coordinated in conjunction with the contractor and appropriate waste disposal company based on actual spoil volume, conditions observed, and the disposal facility requirements.

EPA COMMENTS

General Comments

1. *EPA understands that due to slope constraints, the alignment of the groundwater barrier wall will be setback 20 feet inland of the top of the riverbank, leaving a "stranded wedge" of light non-aqueous phase liquid (LNAPL) and related contaminants outside of the barrier wall, uncontained, adjacent to the Willamette River. The BOD report should evaluate the feasibility of source control measures to address this area and provide justification on why source control is not planned for contaminants in this area.*

Based on recent TZW sampling, there is no indication of LNAPL reaching transition zone under current conditions. Installation of the wall will decrease the hydraulic gradient of the "stranded wedge" area thereby significantly reducing mass flux. Oxygenation upgradient of the wall will result in oxygenated water moving below and around the GWBW, promoting further attenuation of the LNAPL and immobilization of arsenic and manganese. Treatment of the "stranded wedge" will be slow, but attenuation processes will continue and be promoted by the SCM. Based on previous meetings and discussions between representatives of MMGL, ODEQ, and EPA, this approach had been accepted by EPA.

2. *The BOD report includes no information on effect of the proposed groundwater barrier wall on groundwater flow direction and lateral migration of LNAPL, dissolved TPH, and related contaminants. Construction of the barrier wall will potentially result in groundwater mounding on the upgradient side of the wall, which would result in lateral movement of LNAPL and dissolved contaminants potentially around the ends of the wall. An evaluation of the effect of the barrier wall on groundwater and contaminant movement should be added to the BOD report. Contingency measures to address lateral movement of LNAPL and dissolved contaminants along and around the barrier wall should be included in the design.*

The GW SCM presented in this report includes a GWBW to physically separate the affected upland portions of the site from the Willamette River, and an upgradient oxygenation/biobarrier system to oxygenate the aquifer and promote degradation and stabilization of LNAPL and dissolved phase contaminants. As noted in the responses to DEQ comments above, previous groundwater flow model and particle tracking results indicated that the groundwater flow path to the Willamette River will be extended by approximately 3 years following GWBW installation. The oxygenation/biobarrier system is intended to mitigate dissolved phase impacts thereby reducing the lateral and downward movement of contaminants.

3. *The purpose of the groundwater barrier wall, as stated in Section 2.3, is to prevent potential migration of LNAPL and dissolved phase TPH to the Willamette River; however, the proposed barrier wall alignment depicted in Figure 3 is not of sufficient length to prevent LNAPL and dissolved TPH from reaching the river. Specifically, LNAPL and related contaminants were detected at wells MW-18 and MW-24 at concentrations exceeding the Portland Harbor Preliminary Remediation Goals (PRGs). These wells are located at or beyond the proposed endpoints of the groundwater barrier wall; therefore, contaminants detected at these wells are not expected to be completely captured by the barrier wall. The proposed extent of the barrier wall appears to be based only on the most recent monitoring data from June 2015 as no other recent monitoring data is provided. Based on data presented in the 30 January 2013 Southern PEO Investigation Technical Memorandum (Treadwell & Rollo 2013) the following contaminants were detected at MW-18 and MW-24:*
   - *At MW-18 a sheen was observed and TPH-gasoline was detected at 190 micrograms per liter (µg/L). The current PRG for TPH (C10-C12 alphatic) is 2.6 µg/L (RAO 8).*
   - *At MW-24, TPH-gasoline was detected at 28 µg/L, exceeding the PRG (RAO 8).*

The most recent groundwater monitoring data, in addition to the June 2015 data, should be included in tables and figures of the BOD report to determine if the June 2015 data is representative of current conditions and the barrier wall design should be updated, if needed. The proposed barrier wall alignment should be extended to capture contaminants detected at MW-18 and MW-24 or the BOD report should provide an explanation of how contaminants detected at concentrations exceeding the PRGs in these areas will be addressed.

As noted in the response to DEQ specific comment 4, above, the purpose the GW SCM, including the first phase of the GWBW and the second phase of the proposed oxygenation/biobarrier system, is to control the potential migration of LNAPL into TZW and mitigate dissolved metal contaminant phase impacts. The primary objective of the GWBW is to control potential migration of LNAPL to the Willamette River.

Neither MW-18 nor MW-24 had measurable LNAPL during monitoring in 2014, and the proposed GWBW extends beyond MW-23 where the thickness of LNAPL is minimal (0.09 inches in 2014). Based on Treadwell & Rollo's *Southern PEO Investigation Technical Memorandum* (Technical Memorandum) dated January 30, 2013, LNAPL at the site is considered to have relatively low mobility. Additionally, the groundwater gradient, as shown in 2012 monitoring events, is toward the southwest at MW-18 and toward the west at MW-24, toward the area represented by the bend of the GWBW alignment, and therefore it is anticipated that LNAPL in these areas will be effectively captured by the proposed GWBW alignment. Further, it is anticipated that the area of influence of oxygenation/biobarrier system will extend beyond the wall as oxygenated water will disperse laterally along the wall to the areas around MW-18 and MW-24, and treat the observed contaminants.

4. *As stated in* Section *2.2.2, the extent of dissolved arsenic is larger than the extent of the LNAPL plume; however, the conceptual extent of the oxygenation/biobarrier area shown in Figure 3 appears to be limited to the location of the LNAPL plume. Based on data presented in Treadwell & Rollo 2013, dissolved arsenic exceeds the PRG at wells MW-18 and MW-24, which are located at and near the limit of the conceptual extent of the oxygenation/biobarrier area. For example, the 2012 dissolved arsenic concentration at MW-18 was 0.61 μg/L, which exceeds the PRG (RAO 4) of 0.02 μg/L. The BOD report should identify the area that is impacted by arsenic exceeding the PRG, present criteria for what areas will be included in the oxygenation/biobarrier treatment area, and discuss how areas with dissolved arsenic exceeding the PRG will be addressed.*

The As concentrations were evaluated as a line of evidence for source control evaluation. Exceedances of the PRG do not necessarily trigger or require remediation; however, the exceedances require further risk evaluation and determination of the applicability of the PRG. See also the response to DEQ Specific Comment 3 above.

5. *EPA understands that design, permitting, and construction contracting for the groundwater barrier wall is currently underway, before completion of the groundwater source control evaluation and before completion of the conceptual design for the oxygenation/biobarrier system. The introduction of the BOD report should provide an overview of the upcoming key decision and design documents for the groundwater source control and explain how decisions made in these documents will affect the design of the groundwater barrier wall.*

Preparation of the *Upland Transition Zone Water Investigation Report and Source Control Evaluation* is underway. Elevated dissolved arsenic and manganese concentrations are caused by mobilization of naturally occurring arsenic and manganese in the reducing conditions created as a result of the de-oxygenation of the aquifer from biological degradation of the LNAPL. The second phase of the GW SCM, the oxygenation/ biobarrier phase, will introduce oxygen into the subsurface to re-oxidize and immobilize dissolved arsenic and manganese. The design process for the oxygenation/biobarrier phase will include:

- Technology selection (including pilot study);
- System design (including final performance monitoring plan);
- Construction/implementation;
- Performance monitoring and evaluation of the monitoring results; and
- If needed, implementation of an adaptive management process to meet objectives of source control.

6. *The results of the bench scale slurry testing are an important part of the basis of design and should be provided in the BOD report.*

See response to DEQ Specific Comments 6c above.

7. *Design decisions such as type of slurry wall construction and slurry mix design are to be provided by the contractor. EPA requests the opportunity to review and comment on the contractor's selected slurry wall construction method, slurry mix bench scale tests, and final slurry mix selection.*

As noted in response to the DEQ comments above, One-Pass Trenching has been the selected construction method and the contractor is being retained on a performance-based contract.

8. *Source control remedial action objectives (RAOs) and numerical groundwater cleanup levels (CULs) should be provided and used in the BOD report. These are critical in evaluation of the basis of design of the groundwater source control method.*

EPA-published CULs were revised several times during the design phase of the GWBW. The RAOs will be further reviewed in the pending groundwater source control evaluation document.

The design of oxygenation/biobarrier system and associated final performance monitoring plan will incorporate applicable RAOs, and the current draft CULs.

Specific Comments
Basis of Design Report

1. *Section 1.1.2, Page 2, paragraph 2 – This paragraph should reference the documents under which the groundwater source control remedy was developed and the DEQ decision*

document (i.e., the 2014 Revised Feasibility Study and DEQ's 2014 Recommended Alternative for LNAPL and Groundwater Source Control).

Comment noted.

2. *Section 2.1, Page 4, last paragraph – This paragraph should specify the timing of the submittal of the Upland Transition Zone Water Investigation Report and Source Control Evaluation and the design of the groundwater barrier wall. The SCE report submittal date should be included on the schedule in Appendix C. Clarification should be provided on how the exposure pathway evaluation, the evaluation of the potential applicability of the Portland Harbor RAOs, and the PRGs that will be presented in the SCE report will affect the BOD report and final design.*

Comment noted.

3. *Section 2.2.2, Page 5, first paragraph – This paragraph references the map in Figure 3 and the lateral extent of LNAPL relative to the former tank farm; however, the location of the former tank farm is not shown in Figure 3 or any other figures in the BOD report. Recommend adding the location of the former tank farm to Figure 3. The extent of LNAPL, based on representative data of the current LNAPL extent, should also be shown in Figure 3.*

Comment noted.

4. *Section 2.2.2, Page 5, last paragraph – Figures showing the extent of dissolved TPH, benzene, chloroethenes, polyaromatic hydrocarbons (PAHs), arsenic, and manganese should be presented to support the discussion of the extent of groundwater impacts. Without presentation of this information, the basis of design of the groundwater source control measure cannot be evaluated.*

Isoconcentration and concentration data figures were presented in Treadwell & Rollo's Technical Memorandum dated January 30, 2013. Additionally, data figures showing the extent of selected compounds are being produced as part of the *Upland Transition Zone Water Investigation Report and Source Control Evaluation*.

5. *Section 2.4.1.1, Page 7 – The presence of underground utilities or large debris could affect the design of the groundwater barrier wall. If a utility survey along the barrier wall alignment has not been completed yet, EPA recommends that one be conducted soon so that changes can be made prior to construction.*

Comment noted.

6. *Section 2.4.3, Page 8, fourth paragraph – The maximum in situ hydraulic conductivity*

requirement for the groundwater barrier wall is not specified in this section. The BOD report should provide this value and a rationale for why the value is sufficient to provide an effective barrier to prevent migration of LNAPL and dissolved TPH to the river. Both the wall thickness and the maximum in situ hydraulic conductivity should factor into this evaluation.

The GWBW will be 30 inches wide with a design specified hydraulic conductivity of 1x10-6 cm/sec. With the increased bentonite percentage proposed by DeWind, the actual permeability will likely be lower. Note that the GWBW is not specifically intended for hydraulic control.

7. *Section 2.4.5, Page 9 – The LNAPL distribution shown in Figure 3 is based on the gauging results from the June 2015 monitoring event. Supporting data should be presented showing the historical LNAPL thickness over time for each of the wells in Figure 3. The historical data will show variability in LNAPL thickness at each well including seasonal variations. EPA review of the LNAPL thickness data presented in the 30 January 2013 Southern PEO Investigation Technical Memorandum (Treadwell & Rollo 2013) indicated significant variations in the LNAPL thickness between measurements collected in April 2012 and August 2012. For example, the LNAPL thickness at MW-12 was 0.27 feet in April 2012 and 1.28 feet in August 2012 and at MW-18, a sheen was observed in April 2012 and no LNAPL was observed in August 2012. Review of the historical LNAPL thickness at each of these wells will determine if the June 2015 measurements shown in Figure 3 are representative of year-round conditions at these wells or biased by seasonal variation.*

The GWBW was proposed to control the potential migration of LNAPL toward the Willamette River. See also response to general comment number 3 above.

8. *Section 5.0, Page 14, first paragraph – The performance monitoring plan for the groundwater barrier wall should be completed as part of the barrier wall design because performance monitoring and contingency measures are a critical design component. According to the schedule presented in Appendix C, the draft performance monitoring plan will not be completed until 26 February 2016, which is 8 months after completion of the groundwater barrier wall construction. Due to the potential for the groundwater barrier wall to cause lateral LNAPL and dissolved contaminant migration around the wall, performance monitoring should be commenced immediately following completion of construction. The results of performance monitoring should be available to trigger contingency measures, if needed.*

As noted, a conceptual performance monitoring plan and schedule was provided in the BOD. Based on findings of the Technical Memorandum, LNAPL on the site has "relatively low mobility, and is stable in its current configuration" and therefore the timing of the proposed monitoring plan is considered appropriate. Previous communications with the EPA (Rich Muza) were in agreement with this approach. Water level and LNAPL thickness gauging in existing wells can be initiated following completion of construction of the GWBW, prior to presentation of the final Performance Monitoring Plan, and the presence and thickness of LNAPL will be evaluated.

Groundwater Barrier Wall Technical Specifications:

1. *Section 01430-1.05 – This section should include a reference to Contaminated Materials Management Plan in Appendix B for contaminated water and soil handling, testing, and disposal requirements.*

Comment noted. Part 1.05, Specification 01430 - Environmental Protection will be updated to reference the Contaminated Materials Management Plan.

2. *Section 01700 – Specify that the Contractor shall provide well abandonment records to the OWNER and regulatory agencies per OAR Section 690 Division 240.*

Comment noted. Specification 01700 - Contract Closeout will be updated to require the contractor to provide the well abandonment records to the Owner and Regulatory agencies.

3. *Section 02200-1.01.D – Specify that the Contractor shall not use potentially contaminated soil on site. Representative soil samples should be collected of any soil used as backfill demonstrating that contaminant concentrations are below the PRGs.*

Part 1.01.D, Specification 02200 - Earthwork will be updated to indicate that the Contractor shall not use potentially contaminated soil for the cap or surface grading. Additionally, a requirement for sampling soils designated for use in surface grading will be provided in Specification 02200. The contractor will be responsible for providing test results of imported cap materials, or ODEQ concurrence on acceptable sources of fill. See also the response to ODEQ specific comment 13b.

4. *Section 02242-1.04.D – Specify which ODEQ stormwater requirements will be included.*

The approved 1200-C permit is included in Attachment F. Part 1.04.D, Specification 02242 - Groundwater Barrier Wall will be modified to reference that the contractor shall comply with storm-water requirements contained in the drawings

5. *Section 02242-2.05.D – The contractor is allowed to reuse soil from the trench if it "meets the specifications." Add a reference or provide the actual "specifications."*

Excess spoils will not be re-used on-site. The primary criterion for the groundwater barrier wall is permeability. The permeability requirement and other parameters considered to achieve the permeability specification are presented in Table 02242-1 for each construction method. It is important to note that the soil-reagent slurry wall is the only method that requires testing of the soil backfill; therefore, the continuous trenching method employed by DeWind for installation of a soil bentonite slurry wall does not require soil backfill testing. Part 2.05.D, Specification 02242 - Groundwater Barrier Wall will be updated to reference Table 02242-1.

6. *Section 02250-1.02.C- Specify which ODEQ off-site disposal policies will be included.*

The contractor is required to meet all federal, state and local requirements that pertain to the transportation of waste materials. In lieu of listing specific regulations, which could inadvertently omit a requirement, it is preferable to require compliance with all applicable requirements. Part 1.02.C, Specification 02250 - Transportation and Disposal of Materials Section 02250-1.02.C will be revised to delete the reference to any particular regulation.

7. *Attachments A through E are referenced but not included with the specifications. Include these attachments and clearly identify them as Attachments A through E. Of particular concern is Attachment E, which is the slurry treatability study. EPA reserves the opportunity to review the slurry treatability study to confirm suitability of site conditions for slurry wall technology.*

Comment noted. See response to EPA General Comment 7 above.

8. *Drawing Sheet 3, Notes 8 and 9 – Note 8 indicates that alternate alignments of the turn in the barrier wall are allowed, but Note 9 indicates that no deviation greater than 5 feet is allowed. Please clarify whether Note 9 supersedes Note 8.*

Note 8 supersedes Note 9; if an alternative alignment is proposed, the contractor is required to submit the alternative alignment to the engineer for review and approval prior to implementation. The intent is to solicit and evaluate alternative approaches in the bidding process that may result in a wall alignment that is closer to the riverbank than the standard sweeping bend presented on the drawings. For clarification, the first sentence of Note 9 will be modified as follows, "…laterally from the alignment depicted herein, or approved alternate."

9. *Drawing Sheet 4, Note 7 – What defines a storm event should be provided.*

Comment noted. Notes 1 through 10 under "The City of Portland Erosion and Sediment Control Notes" are notes specified by the City to be incorporated on the drawing. These notes have been incorporated verbatim as provided by the City. The City's Erosion and Sediment Control Regulations define "storm event" as "a storm that produces one-half inch or rain or more during any 24 hour time period." Portland City Code 10.20.010.B(38).

10. *Drawing Sheet 4 – Stabilization is needed of the gap between the decontamination pad/tire wash and the street.*

The area between the street (North Burgard Way) and the tire wash is comprised of a paved area and a gravel area. Both of these areas currently provide surface stabilization and neither area is designated for removal or excavation. Therefore, the existing conditions provide a stabilized surface in the referenced area.

TZW
If you have any questions or comments regarding this information, please contact either of the undersigned.

Sincerely,
Environmental Resources Management

Brendan Robinson, P.E.
Project Manager

Erik Ipsen, P.E.
Partner

Attachments:
Attachment A – Communication Plan - Upland Source Control Measures
Attachment B – Draft Construction Quality Assurance/Quality Control Plan – Groundwater Source Control Measure, Groundwater Barrier Wall
Attachment C – ERM HASP
Attachment D – Groundwater Barrier Wall Conceptual Design and Setback (stamped)
Attachment E – Initial Compatibility Test Report (54 Day)
Attachment F – 1200-C Permit
Attachment G – Revised CMMP

THIS PAGE INTENTIONALLY LEFT BLANK

Attachment A
Communication Plan -
Upland Source Control Measures

Memorandum

Environmental Resources Management

1001 SW 5th Avenue
Suite 1010
Portland, OR 97204
(503) 488-5282
(503) 488-5142 (fax)

To: Erin McDonnell/Oregon Department of Environmental Quality

From: Brendan Robinson, PE/ERM
Erik Ipsen, PE/ERM

Cc: Tom Graf/GrafCon

Date: 23 September 2015

Subject: Communication Plan
Upland Source Control Measures
Premier Edible Oils Site, Portland, Oregon

On behalf of MMGL, Corp., ERM-West, Inc. (ERM) has prepared this Communication Plan (CP) for the former Premier Edible Oils (PEO) facility ("the site") located at 10400 N. Burgard Way, Portland, Oregon (Figure 1). This CP has been prepared pursuant to the Voluntary Agreement for Upland Remedial Investigation (FI)/Feasibility Study (FS) and Source Control Measures issued by the Oregon Department of Environmental Quality (ODEQ) and signed 6 March 2001 (ODEQ ECDVC-NWR-01-06) (Voluntary Agreement).

The purpose of this CP is to present the communication and reporting requirements prior to, and during, implementation of a groundwater source control measure (GW SCM) which includes installation of a groundwater barrier wall (GWBW).

The objectives of this CP are to:

- Present the reporting and other communication requirements prior to, and during, implementation of the GW SCM; and
- Specify how changes to the approved design or work plan elements (if applicable) will be reviewed and approved by the ODEQ.

Table 1 provides a summary of reporting and communication requirements prior to, and during, construction activities.

PRE-CONSTRUCTION COMMUNICATIONS

Final Design

Following contractor selection and receipt of their construction sequence input, a final design for the GWBW will be submitted to the ODEQ for review.

Final Construction Schedule

A final construction schedule for the GWBW will be provided to the ODEQ at least five days prior to initiation of field activities.

Pre-Construction Conferences

ODEQ will be notified when the Pre-Construction conferences will be held for the construction phase. ODEQ will be provided the opportunity to participate in these meetings.

COMMUNICATIONS DURING CONSTRUCTION

Progress Meetings

Approximately weekly progress meetings will be held between the site contractors, MMGL representatives, and the project engineer. Additionally, "special meetings" may be convened as necessary. ODEQ will be notified of the progress meeting schedule and any special meetings. ODEQ will have the option of attending these meetings.

Progress Reporting

Short, summary-style progress reports will be submitted to the ODEQ Project Manager via email on a weekly basis and will include the following:

- A summary of work completed during the week;
- Problems encountered and corrective actions taken (if applicable);
- A schedule update;
- Available construction quality control and quality assurance data; and
- Deviations from approved plans (if applicable).

Emergency Communication

Spills and Releases

In the event that materials are dropped or spilled from a truck during transportation, MMGL (or its representative) will notify the ODEQ Project Manager, and the Oregon Emergency Response System (if necessary).

Emergency Actions

MMGL (or its representative) will notify the ODEQ within 24 hours of any emergency actions taken to address the release or threatened release of hazardous substances at the site, other than those required by the Voluntary Agreement.

Archeological Discoveries

If archeological objects or human remains are discovered during field activities at the site, as required by the Voluntary Agreement, MMGL (or its representative) will:

- Provide any notifications required by Oregon Revised Statute (ORS) 97.745 and ORS 358.920; and
- Notify the ODEQ Project Manager within 24 hours of the discovery.

Variations from the Work Plan

Any unexpected conditions, alternative activities, or other variations from the ODEQ-approved work plans will, to the greatest extent practicable, be identified and communicated to the ODEQ before the respective scope of work is conducted. These conditions and variations will be communicated in the weekly email to the ODEQ, as described above. If variations from the approved work plans are encountered during field activities, all variations will be documented in the progress reports submitted to the ODEQ, and MMGL (or its representative) will notify the ODEQ's Project Manager verbally of the variation as soon as possible, but no later than 24 hours after the variation is identified.

Changes to Schedule

If any event occurs that causes, or might cause, a significant delay or deviation in the scheduled GW SCM construction, MMGL (or its representative) within 24 hours will notify the ODEQ's Project Manager verbally of the cause of the delay or deviation and whether the cause is beyond MMGL's reasonable control. The notification will also include the anticipated duration; the measures that have been or will be taken to prevent or minimize the delay or deviation, and the timetable by which MMGL proposes to carry out such measures. MMGL (or its representative) will confirm in writing this information within five working days of the verbal notification.

Table

Table 1
Summary of Reporting and Communications Requirements with ODEQ
Communication Plan
Groundwater Source Control Measure
Premier Edible Oils Site
Portland, Oregon

Report	Content	Frequency	Timing
Final Design	Final design drawings, technical specifications, planning documents, and construction schedule	Once	Following contractor and vendor procurement
Final Construction Schedule	Schedule of planned construction activities	Once	At least 5 days prior to initiation of construction activities
Weekly Progress Update (Email)	Work completed, problems encountered, corrective actions, schedule update, deviations from approved plans	Every Week	During construction activities

THIS PAGE INTENTIONALLY LEFT BLANK

Attachment B
Draft Construction Quality Assurance/ Quality Control Plan – Groundwater Source Control Measure, Groundwater Barrier Wall

THIS PAGE INTENTIONALLY LEFT BLANK

MMGL Corp

DRAFT Construction Quality Assurance/Quality Control Plan – Groundwater Source Control Measure, Groundwater Barrier Wall

Southern Premiere Edible Oils Site
Portland, Oregon

September 2015

Environmental Resources Management
1001 SW 5th Avenue, Portland Oregon, 97204

MMGL Corp

DRAFT Construction Quality Assurance/Quality Control Plan - Groundwater Source Control Measure Groundwater Barrier Wall

Southern Premiere Edible Oils Site
Portland, Oregon

September 2015

Brendan Robinson, P.E.
Project Manager

Erik Ipsen, P.E.
Partner-in-Charge

Environmental Resources Management
1001 SW 5th Avenue
Suite 1010
Portland, Oregon 97204
(503) 488-5282

TABLE OF CONTENTS

LIST OF FIGURES

1.0 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

1.1 PURPOSE

On behalf of MMGL Corporation (MMGL), ERM-West, Inc. (ERM), has prepared this Construction Quality Assurance/Quality Control (CQA/QC) Plan for the Premier Edible Oils (PEO) property (the site) located at 10400 North Burgard Way in Portland, Oregon. The purpose of this document is to present the CQA/QC requirements for construction of the Groundwater Source Control Measure (GW SCM) Groundwater barrier wall (GWBW) and the related construction certification report. This CQA/QC Plan defines the various management and inspection staff personnel directly responsible for the construction quality control (CQC) activities, as well as construction quality assurance (CQA) activities, including position descriptions, responsibilities, and experience requirements. In addition, this CQA/QC Plan addresses specific quality assurance and quality control (QA/QC) testing requirements for each of the various components of the GWBW construction. During construction, contractors, vendors, and others involved in the implementation of the GWBW, will be required to provide supplemental supporting documents. These supplemental requirements will be outlined in the technical specifications.

2.0 POSITION RESPONSIBILITIES

The construction contractor will be responsible for the quality of construction in the finished product and for compliance with the construction documents, drawings, and specifications. The Owner's Representative, designated by MMGL, will have ultimate responsibility for the oversight of construction and for conformance with the construction drawings, specifications, and quality assurance requirements. The Project Engineer will support the Owner's Representative throughout implementation. For the remainder of this document, reference to the Owner or MMGL includes the Owner's Representative; the Owner's Representative is GrafCon.

The CQC team members will be employed by the construction contractor. Therefore, specific positions, and their associated descriptions and responsibilities, will be set forth by the contractor procured. However, it is required that the contractor assign an individual to manage the CQC team. The complete construction, design, CQC and CQA team organization is presented on Figure 1.

2.1 CONSTRUCTION QUALITY ASSURANCE TEAM

The CQA team will primarily focus on the quality assurance activities of the project. This team will, however, possess all of the credentials, capabilities, and experience of an independent design/construction oversight team. The duties and responsibilities of each position are described below. One individual or entity may perform multiple CQA responsibilities.

<u>Project Engineer</u> - The Project Engineer is responsible for overall implementation and management of the CQA/QC Plan and will supervise the preparation of the construction certification report. The Project Engineer will be independent of the construction contractor, but directly accountable to MMGL for the successful completion of the work. The duties and responsibilities of the Project Engineer include the following:

- Review and approve shop drawings.
- Provide support to the CQA Manager in interpreting the meaning and intent of the construction plans and specifications and in the performance and supervision of the CQA testing program.
- Provide consultation and technical support to MMGL.
- Identify, as appropriate and in coordination with the CQA Manager, discrepancies or deficiencies in project work. Any deficiencies deemed by the Project Engineer to require immediate attention will be reported to MMGL immediately.

- Sign, certify, and seal the construction certification report as a Professional Engineer registered in the state of Oregon, who attests to the quality of the work being certified. The report will include the results of all CQA and CQC testing and deviations from the construction plans and specifications. In addition, the report will include "as-built" drawings, daily inspection reports, photographs, and other applicable documents.
- Prepare the final "as-built" drawings indicating the features constructed and the existing location of all features.
- Make recommendations to MMGL regarding the approval of construction subcontractors and material vendors.
- Evaluate the contractor's project schedule.
- Review and make recommendations to MMGL regarding any delays to the project schedule.
- Review and evaluate change orders proposed by the contractor, owner, designer, or CQA team. All change orders will require a signature indicating approval from all above-referenced parties as well as the ODEQ.
- Provide other technical support to MMGL as required.

CQA Manager - The CQA Manager will report directly to the Project Engineer. The duties and responsibilities of the CQA Manager include the following:

- Perform and/or oversee CQA testing activities.
- Coordinate CQA activities with the Construction Manager and the Project Engineer.
- Review contractor invoices and recommend payment schedule to the Project Engineer.
- Maintain copies of all CQA and CQC testing results and certifications.
- Provide input on the construction certification report.

The general purpose of the CQA Manager is to ensure that the contractor provides a full, complete, and properly constructed product in accordance with all plans and specifications. The primary duties of the CQA Manager are to verify that all QA and QC tests required under the construction contract are performed, and assure that all installed equipment and materials have passed the required tests. Upon completion of material and equipment tests, the CQA Manager will maintain reports of testing results, any failures, and any corrective actions employed to obtain acceptable test results. All test data, reporting data, and contractor submissions will be included in the construction certification report. The CQA Manager shall be permitted to suspend construction activities under conditions such as inclement weather, where they believe the integrity of the GWBW or any of its components will be compromised.

CQA Laboratory - The CQA Laboratory will be an entity independent of both MMGL and the construction contractor, located either on site or off site. It will be responsible for conducting tests on soil materials and soil-reagent mixes to ensure conformance with the contract plans and specifications. The CQA Laboratory will not analyze soils or soil-reagent mixes provided by any party involved with the supply of materials, the construction contractor, or subcontractors. The CQA Laboratory will report directly to the CQA Manager.

Field CQA Inspectors - Field CQA Inspectors will report directly to the CQA Manager and will be present during major construction activities. The duties and responsibilities of this position include the following:

- Visually inspect materials imported to the site for conformance with contract specifications and for variations from tests completed prior to the materials being delivered to the site.
- Obtain samples for CQA testing, as required by the technical specifications or otherwise deemed necessary by the Project Engineer.
- Observe field sampling and testing performed by the contractor's CQC staff, and review test results.
- Observe and record observations regarding the storage and handling of equipment and materials.
- Independently verify quantity calculations.
- Prepare daily reports documenting all contractor activities.
- Assist with the generation of soil volume placement estimates.
- Assist with the preparation of "as-built" drawings.

2.2 *CONSTRUCTION QUALITY CONTROL TEAM*

Key positions in the construction contractor's CQC team will be delineated in the construction contract; e.g., Contractor Superintendent, Contractor CQC Manager, etc. Other CQC positions and responsibilities will be assigned at the discretion of the procured contractor. The construction contractor's CQC team will be subject to the review and approval of the CQA Manager before site mobilization is authorized. Team members may be employed directly by the contractor, or as subcontracted firms or individuals. One individual or entity may perform multiple CQC responsibilities. The CQC team will consist of the following positions, or equivalent:

<u>Contractor Superintendent</u> - The construction Contractor Superintendent will have overall responsibility for implementing the CQC program, including appointment of a CQC Manager, and providing daily construction reports documenting testing and construction activities. The daily reports will be provided to the CQA Manager. The CQC Manager may not be the construction Contractor Superintendent and must be approved by the Project Engineer.

<u>CQC Manager</u> - The CQC Manager will be responsible for overseeing all quality control testing performed by the contractor and providing contractor certification reports to the CQA Manager. Other related duties will include coordinating shop drawing submittals, providing required samples, and coordinating work and testing with the CQA Manager. The CQC Manager will provide daily construction reports which document all testing and describe construction activities performed at the site. The CQC daily report will be provided to the construction Contractor Superintendent and a copy provided to the CQA Manager. The CQC Manager will report directly to the construction Contractor Superintendent.

<u>CQC Laboratory</u> - The CQC Laboratory will be an independent, qualified, soils and materials testing laboratory retained by the contractor. The laboratory will conduct tests on representative soils and soil-reagent mixes at the source facilities of materials brought on site, in the field during activities conducted at the site, and/or at the laboratory to determine compliance with construction contract documents.

<u>Field CQC Inspectors</u> - Field CQC Inspectors will report directly to the CQC Manager and will be present during all major construction activities. The duties and responsibilities of this position include the following:

- Conduct field testing on samples of slurry and soil-reagent backfill or mix to control construction of the GWBW.
- Visually inspect materials imported to the site for conformance with contract specifications and for variations from tests completed prior to the materials

being delivered to the site.

- Perform moisture-density relationship tests on constructed soils to ensure that compaction and moisture content are in conformance with construction specifications.
- Obtain samples for CQC testing.
- Observe and record observations regarding the storage and handling of equipment and materials.
- Prepare daily reports documenting all contractor activities.
- Assist the Construction Manager in the generation of soil volume placement estimates.
- Assist with the preparation of "as-built" drawings.

Land Surveyor - The survey crew will consist of a qualified land surveyor and assistants. The land surveyor will identify and establish initial horizontal and vertical control for the construction contractor and will provide ground and aerial surveying of the site for the preparation of certified "as-built" drawings for inclusion in the construction certification report. The land surveyor must be licensed in the state of Oregon and certify all "as-built" drawings and thicknesses, as required in the technical specifications. The survey crew will report directly to the CQC Manager.

3.0 LEVEL OF EXPERIENCE

3.1 CONSTRUCTION QUALITY ASSURANCE TEAM

Project Engineer - The Project Engineer will be a Professional Engineer registered in the state of Oregon. The Project Engineer will have a thorough knowledge and familiarity with the project and demonstrated experience in the design and construction of various types of groundwater barrier walls (i.e., soil-bentonite slurry wall, soil mixing, jet grouting). In addition, they will have experience in earthwork. The Project Engineer will have a minimum of 10 years experience in civil engineering design and construction.

CQA Manager - The CQA Manager will have experience in civil construction projects including earthwork, and soils and materials testing. The CQA Manager will have a thorough familiarity with the project and testing requirements, and have directly-applicable experience in the testing of materials used to construct groundwater barrier walls. The CQA Manager will have a minimum of five years of experience.

CQA Laboratory - The CQA Laboratory will have experience in testing soils, soil-reagent mixes, and other construction materials, and will be familiar with related American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and other construction materials testing standards.

Field CQA Inspectors - Field CQA Inspectors will have experience and/or training in both the testing and inspection of earthwork, granular materials, groundwater barrier walls, concrete, and other site improvements. The inspectors that perform soil, slurry, and soil-reagent backfill testing will have a minimum of one year experience.

3.2 CONSTRUCTION QUALITY CONTROL TEAM

Construction Contractor Superintendent - The construction Contractor Superintendent will be trained in the areas of landfill/civil/earthwork construction and engineering. The Superintendent will have demonstrated experience in earthwork projects and groundwater barrier wall construction, and will have a familiarity with the project. The Superintendent will have a minimum of 10 years experience in the construction field and with installation of groundwater barrier walls.

CQC Manager - The CQC Manager will have a working knowledge of civil engineering, earthwork, and construction materials testing. The CQC Manager will have demonstrated experience with earthwork projects and groundwater barrier wall construction. The CQC Manager will have a minimum of five years experience in construction and materials testing, including groundwater barrier walls.

Field CQC Inspectors - Field CQC Inspectors will have experience and/or training in both the testing and inspection of earthwork, granular materials, groundwater barrier walls, concrete, and other site improvements. The inspectors that perform soil, slurry, and soil-reagent backfill or mix testing will have a minimum of one year experience performing the required tests, including familiarity with the use and application of sand cones, Marsh funnels, filter presses, slump cones, scales, ovens, Shelby-tube sampling, nuclear density gauges, levels and tripods, and will be certified for operation of a nuclear density gauge.

CQC Laboratory - The CQC Laboratory will be an independent laboratory subject to the approval of the CQA Manager. The CQC Laboratory will have a minimum of three years experience in testing soils, soil-reagent mixes, and other construction materials, and will be familiar with ASTM, AASHTO and other applicable test standards.

Land Surveyor - The Land Surveyor will have at least five years experience as a crew chief in performing topographic surveys, and must be a professional land surveyor registered in the state of Oregon.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL TESTING

QA/QC testing will be conducted for each of the major items under construction. The components of the GWBW construction subject to QA/QC testing include the following:

- GWBW – soil-bentonite slurry wall, continuous trenching, jet grouting, and soil mixing;
- General earthwork - common fill, clay;
- Granular materials;
- Geotextile; and
- Geogrid

Each component is discussed separately below.

4.1 CONTINUOUS TRENCHING

4.1.1 Bentonite

4.1.1.1 Pre-Construction

- The contractor must submit the name of the bentonite supplier, the source of bentonite, and a sample to the CQA Manager prior to construction, in accordance with the Specifications.
- The contractor must submit the results of the following tests: free swell (USP NF XVII), plastic viscosity (API 13A), viscometer (API 13A), and residue larger than 75 micrometers (μm) (API 13A) for each proposed source of bentonite.
- The contractor must submit the results of the following tests: YP/PV ratio (API 13A), filtrate loss (API 13A), and moisture content (ASTM D2216) for each truck or railcar shipment of bentonite.
- The contractor must supply samples of bentonite, as required by the contract specifications, or as requested by the CQA Manager.

4.1.1.2 Construction

- The contractor must supply, for each designated load of bentonite, the bentonite manufacturer's certifications and laboratory test results that demonstrate that the bentonite meets contract specifications.
- The contractor shall keep a log of bentonite deliveries that includes: date, source, time of delivery, weight, and laboratory quality control test results

supplied by the manufacturer.

4.1.1.3 Post-Construction

- No testing required.

4.1.2 Mix Water

4.1.2.1 Pre-Construction

- The contractor must submit the results of the following tests: pH (API RP 13B-1), total dissolved solids (EPA 600), and hardness (API RP 13B-1) for each proposed source of water.

4.1.2.2 Construction

- No testing required.

4.1.2.3 Post-Construction

- No testing required.

4.1.3 Reagent Slurry

4.1.3.1 Pre-Construction

- No testing required.

4.1.3.2 *Construction*

- The contractor must submit the results of the following tests on reagent slurry: viscosity (API RP 13B-1), density (ASTM D4380), and pH (API RP 13B-1). These tests must be performed each time the batch plant begins operation and at minimum of every 2 hours during the installation of the GWBW. Additional samples shall be obtained at the request of the Project Engineer.

4.1.3.3 Post-Construction

- No testing required.

4.1.4 Soil-Reagent Mix

4.1.4.1 Pre-Construction

- No testing required.

4.1.4.2 *Construction*

- The contractor shall obtain samples of the soil-reagent mix as required by the contract specifications and as deemed necessary by the Project Engineer to achieve the performance requirements of the wall.
- The contractor must submit results of the following tests performed once per day or once every 100 lineal feet of installed GWBW whichever is greater frequency at alternating 20 vertical foot intervals: density (ASTM D4380) and permeability (ASTM D5084).
- The contractor shall test the slump (ASTM C143) at the initiation of each day's GWBW installation, and at a minimum of once every two hours during the installation of the GWBW.
- The coefficient of permeability of the soil- reagent backfill must be verified to be less than 1 x 10-6 centimeters per second (cm/sec).
- The contractor shall observe and record the depth of the GWBW every 20 feet along the alignment, to the nearest 0.5 feet.
- The contractor shall maintain a continuous as-built profile of the GWBW.
- The contractor shall confirm that the GWBW extends to 35 feet below ground surface, as required by the contract specifications, using methods approved by the Project Engineer.

4.1.4.3 *Post-Construction*

- The contractor shall obtain undisturbed samples of the soil-reagent mix, as required by contract specifications, and as deemed necessary by the Project Engineer to achieve the performance requirements of the wall. At a minimum, one undisturbed sample of the backfill mix shall be taken from between the ground surface and mid-depth, and one sample from between mid-depth and the trench bottom in two sample locations that are at least 200 feet apart. Continuous coring shall be used to visually confirm uniform GWBW composition that is free of voids. The contractor shall test these samples for permeability (ASTM D5084).
- The coefficient of permeability of the soil- reagent backfill must be verified to be less than 1 x 10-6 centimeters per second (cm/sec).

4.2 *GENERAL EARTH WORK - COMMON FILL*

4.2.1 *Pre-Construction*

- The contractor shall submit the locations of all borrow sources to the CQA Manager no less than two weeks prior to the anticipated placement of any soil materials.

- The contractor shall submit a 50-pound sample from each of the proposed borrow sources. The samples shall be submitted to the CQA Manager no less than two weeks prior to the anticipated placement of any soil material.
- The contractor shall submit with each sample the sample location, a sketch of the sample location, depth of the sample, a description of the soil, the sampling methodology, and estimated available quantity of soil.
- The contractor shall submit the results of the following tests performed once every 2,000 cubic yards for each borrow source (a minimum of three tests per source is required) of common fill : particle-size analyses with hydrometer (ASTM D422), moisture content and density relationship (ASTM D1557), Atterberg limits (ASTM D4318), soil classification (ASTM D2487), and moisture content (ASTM D2216). The test results shall verify that the soils meet the contract specifications and shall be submitted to the CQA Manager no less than one week prior to the anticipated placement of any soil materials.
- The CQA Manager, or designee, shall inspect each proposed borrow source and obtain one sample for independent analysis for particle-size distribution.
- A summary report shall be prepared by the CQA Manager and shall include: a summary of laboratory test data, drawings depicting sample and test locations, a summary of sampling methods, and a brief letter certifying that the available volume of soil meets or exceeds regulatory and construction criteria.

4.2.2 Construction

- The contractor shall test the in-place density and moisture content of all common fill material in accordance with ASTM D6938, and the contract technical specifications. Three tests must be conducted per lift, per area of interest. The common fill will be compacted to 90 percent of the maximum Modified Proctor Density (ASTM D1557), and every 25th nuclear density test and moisture test must be verified in accordance with ASTM D1556 and ASTM D2216, respectively.
- The CQC Manager shall obtain a sample of common-fill material if they note any change in the color, consistency, or texture of the material. The sample shall be tested in accordance with ASTM D422, ASTM D1557, ASTM D4318, ASTM D2487, and ASTM D2216, by the Geotechnical CQC Laboratory.
- The soils shall be placed to achieve uniform compaction at a maximum thickness of 12 inches. The maximum clod size shall not exceed the lift thickness.
- If test results indicate that the in-place common-fill material does not meet the required specifications, the material shall be removed, replaced, and re-tested at the contractor’s expense.

- The final grade of all common-fill soils shall be smooth and even, and measure to within two-tenths of a foot below to five-tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. All thicknesses and "as-built" drawings are required to be certified by the Land Surveyor.

4.2.3 *Post-Construction*

- The in-place common-fill material shall be protected from rain, drying, desiccation, and erosion.
- Any and all defective areas, as defined by the CQA Manager, shall be removed, repaired, and re-tested at the contractor's expense.
- Prior to the placement of any covering material, the common-fill material shall be inspected and approved by the CQA and CQC Managers. The common-fill material shall be inspected for cracks, holes, defects, or other features that may be detrimental to structural performance, as determined by the CQA Manager.

4.3 *GENERAL EARTHWORK - CLAY*

4.3.1 *Pre-Construction*

- The contractor shall submit the locations of all borrow sources to the CQA Manager no less than two weeks prior to the anticipated placement of any soil materials.
- The contractor shall submit a 50-pound sample from each of the proposed borrow pits. The samples shall be submitted to the CQA Manager no less than two weeks prior to the anticipated placement of any soil materials.
- The contractor shall submit with each sample the sample location, a sketch of the sample location, depth of the sample, a description of the soil, the sampling methodology, and estimated available quantity of soil.
- The contractor shall submit the results of the following tests performed once every 2,000 cubic yard for each borrow source (a minimum of three tests per source required) of clay: particle-size analysis with hydrometer (ASTM D422), moisture content (ASTM D2216), Atterberg limits (ASTM D4318), moisture content and density relationship (ASTM D1557), soil classification (ASTM D2487). A minimum of two tests per source is required for permeability (ASTM D5084). The test results shall verify that the soil meets contract specifications, including a laboratory permeability less than or equal to 1 x 10-6 cm/sec. The test results shall be submitted to the CQA Manager no less than one week prior to the anticipated placement of any clay soil furnished from off site.

- The CQA Manager, or designee, shall inspect each proposed borrow source and obtain one sample for independent analyses of particle-size distribution.
- A summary report shall be prepared by the CQA Manager and shall include: a summary of laboratory test data, drawings depicting sample and test locations, a summary of sampling methods, and a brief letter certifying that the available volume of soil meets or exceeds regulatory and construction criteria.

4.3.2 Construction

- The contractor shall test the in-place density and moisture content of all clay material in accordance with ASTM D6938, and technical specifications. Tests shall be conducted every 50 lineal feet on each lift. The clay shall be compacted to 90 percent of the maximum Modified Proctor Density (ASTM D-1557), and nuclear density tests and moisture tests shall be verified in accordance with ASTM D1556 and ASTM D2216, respectively. A minimum of three verification tests shall be conducted for each soil material type.
- The CQC Manager shall obtain a sample of clay if any change in the color, consistency, or texture of the material is noted. The sample shall be tested in accordance with ASTM D422, ASTM D2216, ASTM D2487, ASTM D1557, ASTM D5084, and ASTM D4318, by the Geotechnical CQC Laboratory.
- If test results indicate that the in-place material does not meet the required specifications, the material shall be removed, replaced, and re-tested at the contractor's expense.
- The final grade of all clay material shall be smooth and even, and measure to within two-tenths of a foot below to five-tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. The minimum thickness shall be achieved. All thicknesses and "as-built" drawings are required to be certified by the CQC Surveyor.

4.3.3 Post-Construction

- The in-place material shall be protected from rain, drying, desiccation, and erosion.
- Any and all defective areas, as defined by the CQA Manager, shall be removed, repaired, and re-tested at the contractor's expense.
- Prior to the placement of any covering material, the clay material shall be inspected and approved by the CQA and CQC Managers. The clay material shall be inspected for cracks, holes, defects, or other features that may be detrimental to the structural performance, as determined by the CQA Manager.

4.4 GRANULAR MATERIALS

4.4.1 Pre-Construction

- The contractor shall submit the location of all borrow sources to the CQA Manager no less than two weeks prior to the anticipated placement of any granular materials.
- The contractor shall submit a 50-pound sample from each of the proposed borrow sources. The samples shall be submitted to the CQA Manager no less than two weeks prior to the anticipated placement of any granular materials.
- The contractor shall submit with each sample the sample location, a sketch of the sample location, depth of the sample, a description of the granular material, the sampling methodology, and estimated available quantity of granular material.
- The contractor shall submit the results of the particle-size analyses for Dense Graded Aggregate (AASHTO T 27) and gravel (ASTM C-136) conducted for every 1,000 cubic yards of granular material imported to the site. The test results shall be submitted to the CQA Manager no less than one week prior to the anticipated placement of any granular materials.
- The CQA Manager, or designee, shall inspect each potential borrow source and obtain one sample for independent analysis of particle-size distribution.

4.4.2 Construction

- If test results indicate that the in-place material does not meet the specifications, the material shall be removed, replaced, and retested at the contractor's expense.
- The final grade of the granular material shall be measured to within two-tenths of a foot below to five tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. All thicknesses and "as-built" drawings are required to be certified by the CQC Surveyor.

4.4.3 Post-Construction

- The CQA Manager shall perform thickness measurements in the field to check compliance with contract specifications. All thicknesses are required to be certified by the CQC Surveyor.

4.5 GEOTEXTILES

4.5.1 Pre-Construction

- A minimum of two weeks prior to the anticipated placement of any geotextile, the Contractor must submit the name and manufacturer, and the specific product of the manufacturer, certificate of compliance.

- A minimum of two weeks prior to the anticipated placement of any geotextile filter material, the Contractor must submit manufacturer's quality control data test results for flow rate (ASTM D-4491); permeability (ASTM D 4491); trapezoidal tear strength (ASTM D-4533); grab elongation (ASTM D-4632); fabric weight (ASTM D-3776); puncture strength (ASTM D-4833) and apparent opening size (ASTM D-4751) for all proposed geotextile fabrics.

4.5.2 Construction

- The CQA Manager will inspect the physical condition of the material. The CQA Manager will inspect the materials to verify that no visible damage is noted.
- The CQA Manager will be responsible for verification that the geotextile material is stored out of direct sunlight and is protected from precipitation and physical damage.
- The CQA Manager will inspect the placement of the geotextile and verify that no foreign materials are trapped within the fabric, and that proper installation techniques are utilized.

4.5.3 Post-Construction

- No testing required.

4.6 GEOGRID

4.6.1 Pre-Construction

- A minimum of two weeks prior to the anticipated placement of any geotextile, the Contractor must submit the name and manufacturer, the specific product of the manufacturer, and certificate of compliance.
- A minimum of two weeks prior to the anticipated placement of any geogrid material, the Contractor must submit shop drawings showing anchoring details and other details pertinent to the installation of the geogrid.
- A minimum of two weeks prior to the anticipated placement of any geotextile filter material, the Contractor must submit the following information to the CQA manager:
    1. Origin and production date of the resin;
    2. A copy of the quality control certificates issued by the resin supplier;
    3. Reports of tests conducted by the Manufacturer to verify that the material is in conformance with all

requirements identified in the technical requirements and;

4. Certification that no reclaimed polymer is added to the resin.

4.6.2 Construction

- The CQA Manager will inspect the physical condition of the material. The CQA Manager will inspect the materials to verify that no visible damage is noted.
- The CQA Manager will be responsible for verification that the geogrid material is stored out of direct sunlight and is protected from precipitation and physical damage.
- The CQA Manager will inspect the placement of the geogrid and verify that no foreign materials are trapped, and that proper installation techniques are utilized.

4.6.3 Post-Construction

- The CQA and CQC manager will conduct inspection of the finished work prior to the placement of any materials on top of the geogrid. The inspection will include verification of all required ties and physical conditions; any accumulated dust and dirt discovered must be removed by the Contractor.

5.0 CONSTRUCTION CERTIFICATION REPORT

The Construction Certification Report will be prepared by the Project Engineer and submitted to the ODEQ. The report will be assembled and submitted within 45 days following completion of the GWBW, and will include the following information:

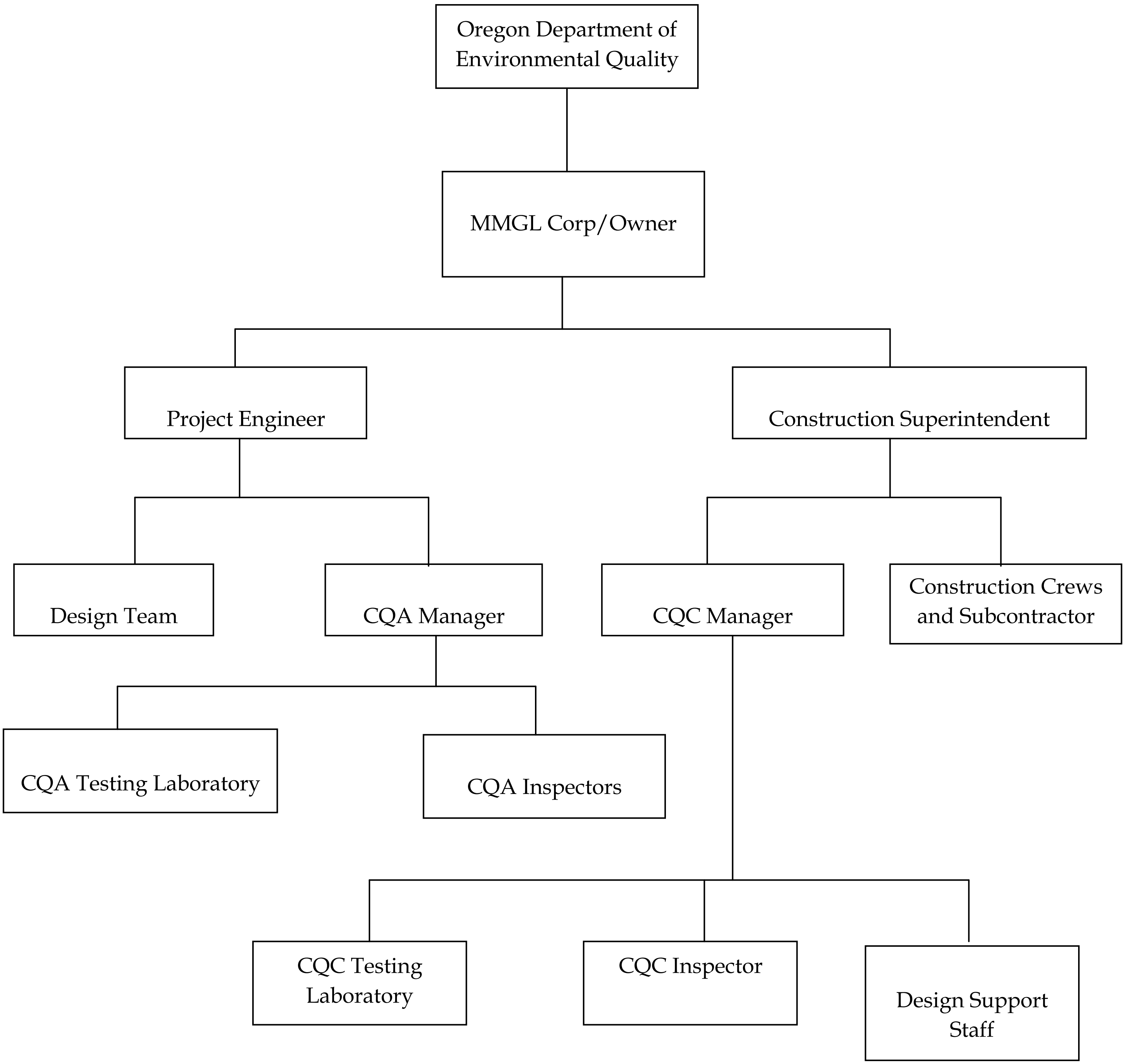
- Results of CQA and CQC testing;
- Documented deviations from the Final Design;
- Record or "as-built" drawings, including:
  - Plan views with test locations;
  - Cross sections; and
  - Necessary details;
- Daily reports;
- Site photographs;
- A statement of certification and compliance, signed and stamped by the supervising Professional Engineer registered in the state of Oregon, for GWBW components including:
  - The groundwater barrier wall; and
  - The clay cap; and
- The professional land surveyor certification for the GWBW location.

6.0 *CONTINGENCY PLAN*

During construction of the GWBW components, construction difficulties may occur. The following is a list of potential construction difficulties and contingent solutions:

- Trench instability – Slurry elevation within the trench can be increased to bring the slurry closer to the ground surface and/or slurry density can be increased.
- High permeability lenses within the trench – Trench segments containing high permeability lenses can be re-excavated and filled with soil-bentonite backfill or grouted.
- Soil materials too wet - Soil can be disked or harrowed and allowed to dry until the appropriate moisture content is obtained.
- Soil materials too dry - Moisture can be added with the addition of water and thorough mixing, via disking.
- Erosion of newly placed soil - Eroded areas will be repaired immediately and will be maintained until granular materials are placed. Additional soil will be placed and compacted in affected areas. Extra silt fences will be installed as necessary to retard/redirect flows. Erosion mats, riprap or other controls will also be evaluated on a case-by-case basis.
- Inclement weather impeding the progress of the work - In the event that weather makes work difficult or affects the integrity of the work (i.e., freezing conditions during soil placement), work will be suspended until weather conditions permit.
- Stormwater ditches, ponds, and culverts clog with sediments - All excess sediment will be removed from ditches and culverts, as necessary, for proper operation.
- Cover system soils may settle - Any significant settlement will be repaired immediately through the addition of fill material.

FIGURE 1 - PROJECT ORGANIZATION CHART



Attachment C
ERM HASP

THIS PAGE INTENTIONALLY LEFT BLANK

This Level 2 health and safety plan (HASP) is intended to provide health and safety guidelines for project work meeting one or more of the following criteria:

- Some likelihood of physical and/or chemical hazard exposure (e.g., sampling, use of equipment and tools);
- Number of job tasks is five or greater;
- Use of subcontractors;
- Work meets the definition of being "high hazard", which includes, but is not limited to:
    - Activities that could have an adverse effect on the environment (e.g., use of bulk liquid storage tanks, generators, etc.);
    - Air or boat transport via charter or non-commercial carrier/vendor;
    - Confined space entry;
    - Construction;
    - Demolition, Decontamination and Demolition (DDD) operations;
    - Diving;
    - Excavations, trenching, drilling, or other ground disturbance activities (i.e., activities requiring subsurface clearance [SSC] operations);
    - Hazardous energy control operations;
    - Hot work (e.g., welding, flame cutting, or other spark-producing activities);
    - Injection well operations;
    - Off-shore or over water work (including oil platform visits);
    - Rigging and lifting operations; and
    - Work at heights in excess of four feet.

The HASP should be developed with input from the project team and reviewed with all ERM project personnel, including subcontractors. A signed copy of the HASP must be maintained at the project site during work and must be archived in the project files.

H&S Team review is required for the Level 2 HASP. You can e-mail completed plans requiring review to the ERM North America HASP Review Team (ERMNASafetyLeads@erm.com). This HASP must be reviewed by the Project Manager and reviewed/approved by the Partner in Charge (PIC) and updated as warranted to address changes in scope, hazards present, project personnel, etc. At a minimum, HASPs must be reviewed annually or if the scope of work changes. Updated HASPs should also be sent to the H&S Team for review and PIC for approval.

Administrative Information	
This document has been developed for the sole use of ERM staff. Subcontractors and other project participants must develop their own HASP. ***This document is valid for a maximum time period of one year after completion. The document must be reviewed if the scope of work or nature of site hazards changes and must be updated as warranted.***	
Project Name: Southern PEO Groundwater Barrier Wall Installation	Site Name & Location: Southern PEO Site, 10400 N Burgard Way, Portland, Oregon 97203
Client Contact and Phone: Tom Graf / 415-290-5034	GMS Project #: 0283866
Health & Safety Plan Date: 08/06/2015	Revision Number and Date: Rev #3 / 08/06/2015
Field Work Start Date: 09/21/2015	Anticipated Field Work End Date: 09/21/2016
Project Manager: Brendan Robinson	Partner In Charge: Erik Ipsen
Field Safety Officer: Justin Dauphinais	Additional ERM Personnel on site: Scott Terranova, Melody Kieneker, Brendan Robinson, Kathryn Ewing, Shira DeGrood
H&S Team Review	
Reviewer Name: Bradley Bishop Review Date: 09032015	Signature File: Bradley Bishop
Site Description and Scope of Work	
Include relevant background information regarding the site, such as location, size, type of facility, topography, weather, infrastructure, security, previous site use, etc. Describe nature and extent of any soil/air/water/groundwater contamination. Describe any other aspects of the site that may potentially affect the health, safety, or security of on-site personnel. ***Include a description of work to be completed during the project. From this, develop a list of tasks to be completed by ERM personnel, as well as a list of tasks to be completed by subcontractor personnel.***	

Site Description: Flat, 18.5 acre former industrial property on the Portland Harbor waterfront frontage on Willamette River and International Slip. Site elevation 27 to 30 feet MSL, City of Portland datum. Property owner submitted a draft Preliminary Findings Report for the Premier Edible Oils Site dated August 29, 2008. This report presents subsurface investigation data collected from the site in Jan. and Feb. 2008. Monitoring wells and soil borings were installed in Jan. 2008 along the top of bank at the International Slip and Willamette River shorelines and in the uplands portion of the site. Key findings include: free product thickness on the water table fluctuated in shoreline wells ranging from 0.43 - 0.88 feet (MW-9); 1.96 - 2.58 feet (MW-12); 0.04 to 4.04 feet (MW-13); 0.0-2.7 feet (MW-22). Measured product fluctuations are dependent on river stage as influenced by tidal fluctuations. No observed product releases from site or petroleum sheens on river water were observed along the shoreline of the PEO site. Property owner submitted an 11/96 Phase II ESA to DEQ in February 1997, which documented groundwater contamination at this site. Primary contaminants included petroleum hydrocarbons, particularly BTEX and other petroleum-based VOCs. Several well points also contained low levels of chlorinated solvents. The property owner and operator concluded that the contamination originated from the adjacent Time Oil site (ECSI #170). (6/17/99 JMW/SAP) Weston sampling results from the Portland Harbor Sediment Study revealed mercury, cobalt, antimony, barium, PAHs, zinc, copper, manganese, arsenic, carbazole, dibenzofuran, methylnaphthalene, and bis(2-ethylhexyl)phthalate in river sediments adjacent to the site. DEQ has not determined the source(s) of these contaminants. (1/4/02 ACV/VCP) Results of investigation activities conducted through 2001 indicate groundwater impacts in several different locations on the site. Free-phase petroleum is present on groundwater at the southwest corner of the site and appears to be from historic site operations. Low-level chlorinated solvents, PAHs, and VOCs usually associated with gasoline were detected with the free-phase petroleum. This contaminated groundwater plume appears to be distinct from impacted groundwater toward the northeast part of the property. Activities on adjacent Time Oil property may have contributed to groundwater contamination in northeast part of property. Further groundwater investigation is planned in 2002, 2008 and 2009 to more fully characterize groundwater conditions.

Project Background and Scope of Work	
Include list of tasks to be completed by ERM personnel during this project, and a separate list of tasks to be completed by any contractors at the site. A site-specific Job Hazard Analysis (JHA; ERM Form S1-ERM-002-FM4) must be completed for each task to be performed. Contractors must provide their own HASP and a JHA for each task they will perform for ERM review. *A JHA template and reference/example JHAs for more common tasks can be found at: Americas H&S Page - JHAs.*	
ERM Scope of Work: The goal of the source control measure (SCM) is to reduce the potential for migration of site constituents of potential concern (COPCs) to the Willamette River. The groundwater SCM will consist of the installation of an approximately 450 feet long groundwater barrier wall which includes: abandoning select groundwater wells; trenching/excavating, mixing and placing slurry and soil-reagent backfill in the trench, and installation of clay cap on top of the barrier wall. The cap will be flushed with the existing surface. Excess spoils from trenching will be transported off-site for disposal. The SCMs are considered an interim action that is being applied in advance of the selection of a final site remedy that addresses COPCs in soil and groundwater.	
ERM Task 1: Prepare a site-specific health and safety plan (HASP).	☒ JHA Attached?
ERM Task 2: Oversight of excavation and barrier wall construction activities	☒ JHA Attached?
ERM Task 3: Oversight of the abandonment of select groundwater monitoring wells	☒ JHA Attached?
ERM Task 4: Sampling and Soil Testing Activities	☒ JHA Attached?
ERM Task 5: Ovesight of waste disposal	☒ JHA Attached?
ERM Task 6: Click here to enter text.	☐ JHA Attached?
ERM Task 7: Click here to enter text.	☐ JHA Attached?
Contractor Scope of Work: Installation of an approximately 450 feet long groundwater barrier wall which includes: abandoning select groundwater wells; trenching/excavating, mixing and placing slurry and soil-reagent backfill in the trench, and installation of clay cap on top of the barrier wall. Flushing of the cap with the existing surface. Transportation of all excess waste to an off-site for disposal. NOTE: The primary Subcontractor is DeWind who is directly contracted to the client. All other subcontractor work is contracted through DeWind.	
Contractor Task 1: Excavation activities	☐ JHA Reviewed?
Contractor Task 2: Barrier wall construction activities	☐ JHA Reviewed?
Contractor Task 3: Well abandonment	☐ JHA Reviewed?

Contractor Task 4: Waste Disposal	☐ JHA Reviewed?
Contractor Task 5: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 6: Click here to enter text.	☐ JHA Reviewed?
Contractor Task 7: Click here to enter text.	☐ JHA Reviewed?

Contractor(s) to be used:	Approved under Contractor Management Program?
	☐ Yes ☐ No
1. DeWind (Direct Client Subcontractor)	☐ Yes ☒ No
2. Click here to enter text.	☐ Yes ☐ No
3. Click here to enter text.	☐ Yes ☐ No
4. Click here to enter text.	☐ Yes ☐ No

Site/Project General Information			
Site Type (check all applicable boxes)			
☐	Industrial	☐	Hazardous waste release (Hazwoper)
☐	Residential	☒	Remote or Inactive Facility*
☐	Unsecured	☐	Other (specify): Click here to enter text.
☐	Coastal/offshore (on or near water)	☐	Other (specify): Click here to enter text.
*ERM Form S3-NAM-029-FM6 (*Undeveloped, Remote, or Inactive Sites*) must be completed and attached to this document.			
Main Project Hazards (check all applicable boxes)			
☐	Aerial Lift Use (e.g., Scissor Lifts, Cherry Pickers)[1]	☐	Helicopter/Fixed Wing Aircraft Transportation[3]
☐	All-Terrain Vehicle Use[1]	☒	High Noise (>85 dBA)
☐	ASTs/USTs	☐	Hot Work (Welding, Cutting, Brazing)[2]
☒	Biological Hazards	☐	International Travel[4]
☒	Chemical Exposure Potential (including asbestos)	☐	Long Distance/Duration Driving[5]
☐	Chemical Mixing/Injection	☐	Mining (Surface/Underground)
☐	Compressed Gas	☒	Natural Hazards (Plants, Animals, Insects)
☐	Confined Space Entry[2]	☐	Off-Shore Platform Work[6]
☒	Construction[1]	☐	Overhead Power Lines
☐	Control of Hazardous Energy (i.e., Lockout/Tagout)[2]	☒	Portable/Fixed Ladders
☐	DDD Operations[1]	☐	Radiation (Ionizing/Non-ionizing)
☐	Diving[1]	☒	Rigging/Lifting[2]
☒	Ergonomics/Material Handling	☐	Scaffold Use
☒	Excavation/Trenching/Drilling[2]	☐	Shift Work (e.g., night work)
☐	Extended or Nonstandard Work Shifts (>14 hours)	☐	Short Service Employees
☐	Extreme Weather	☒	Slips/Trips
☐	Explosives Use[1]	☒	Subsurface Clearance (Buried Utilities)[2]
☐	Falls from height (>4 feet)[1]	☐	Working on/over Water (including transport)[1]
☒	Forklift/Industrial Truck Use[1]	☐	Unexploded Ordnance/Munitions and Explosives of Concern (UXO/MEC)[1]
☒	Hand/Power Tool Use	☐	Other (specify): Click here to enter text.
☒	Heavy Equipment Use		

1 High hazard work requiring H&S team coordination. Additional control measures may be required beyond JHA.

2 Permit-required high hazard work requiring H&S Team coordination and ERM or equivalent client-required permit to be completed.

3 If traveling using a helicopter or fixed wing aircraft, ERM employees are required to follow the provisions of ERM Standard S1-ERM-009-ST (*Fixed Wing Aircraft and Helicopter Safety*).

4 A Travel Risk Assessment (TRA) is required for all international travel (with the sole exception of travel to a Low Risk country where ERM has a permanent office). Consult ERM Standard S1-ERM-005-ST.

5 If driving more than 500 km (310 miles) in a single day, driving in excess of 4.5 hours in a single day, or driving in a remote location, a Journey Management Plan (see ERM Standard S1-ERM-008-PR) is required and should be appended to this HASP.

6 If traveling to/from and working on an off shore platform, ERM employees are required to follow the provisions of ERM Standard S1-ERM-006-ST (*Offshore Platform Safety*).

Chemical Products Used or Stored On-Site *For each chemical product identified, a Safety Data Sheet (SDS) must be attached to this HASP.*	
☒ Alconox or Liquinox	☐ Household bleach (NaOCl)
☐ Hydrocholoric acid (HCl)	☒ Calibration gas
☐ Nitric acid (HNO_3)	☐ Other (specify): Click here to enter text.
☐ Sulfuric acid (H_2SO_4)	☐ Other (specify): Click here to enter text.
☐ Sodium hydroxide (NaOH)	☐ Other (specify): Click here to enter text.
☐ Isopropyl alcohol	☐ Other (specify): Click here to enter text.

Note: Eyewash solution must be readily available on all project sites where materials are used or stored that pose a risk of getting into the eyes via splashing or through contact with airborne gases, vapors, dusts, or mists. This includes sample preservatives. The eyewash unit, whether stationary or portable, must be large enough to provide at least 15 minutes of eye flushing.

Regulated Chemicals of Concern *Check any chemicals known or suspected to be present on the site to which the ERM team may be exposed. These chemicals include OSHA-regulated potential carcinogens (29 CFR 1910.1003 through 1016) as well as those chemicals for which OSHA has established specific respiratory protection requirements (29 CFR 1910.134). If any of these chemicals are present on site, contact your H&S team member for guidance and describe any additional protective measures to be taken, as necessary.*	
☐ Friable asbestos	☐ Hexavalent chromium
☐ 3,3’-Dichlorobenzidine	☐ Coke oven emissions
☐ Benzidine	☐ Ethylene oxide
☐ Beta-Propiolactone	☐ 1,2-Butadiene
☐ N-Nitrosomethylamine	☐ Methyl chromoethyl ether
☐ Lead	☐ Beta-Napthylamine
☒ Benzene	☐ Ethyleneimine
☐ Acrylonitrile	☐ 4-Dimethylaminoazobenzene
☐ Methylenedianiline	☐ Inorganic arsenic
☐ 4-Nitrobiphenyl	☐ Cadmium
☐ alpha-Napthylamine	☐ 1,2-Dibromo-3-chloropropane
☐ bis-Chloromethyl ether	☐ Formaldehyde
☐ 4-Aminodiphenyl	☐ Methylene chloride
☐ 2-Acetyaminoflourene	☐ **No ERM exposure to these compounds**
☐ Vinyl chloride	

Known or Suspected Chemicals of Concern

The following section must be filled out for all confirmed or suspected chemicals present on the site to which the ERM team may reasonably be exposed. Information on each chemical must be provided to all team members.

Material name: TPH-g - gasoline		Highest reported concentration*: 7.1 ppm – GW 1,500 ppm - Soil	
Primary hazards: Flammable, harmful if swallowed, respiratory tract irritation, skin irritation, eye irritation, central nervous system depression, liver, kidneys		Exposure symptoms: irritation eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid); possible liver, kidney damage; [potential occupational carcinogen]	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**: Not Determined
PEL: Click here to enter text.	REL: Click here to enter text.	TLV: Click here to enter text.	
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV): N/A
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	
Material name: TPH-d - Diesel		Highest reported concentration*: 19 ppm – GW 3,900 ppm - Soil	
Primary hazards: Flammable, harmful if swallowed, respiratory tract irritation, skin irritation, eye irritation, central nervous system depression, liver, kidneys		Exposure symptoms: Eye irritation, pulmonary function changes; [potential occupational carcinogen]	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**: Not Determined
PEL: Click here to enter text.	REL: Click here to enter text.	TLV: Click here to enter text.	
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV): N/A
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	
Material name: Benzene, Ethylbenzene, Xylenes		Highest reported concentration*: Benzene = 6.8 ppb - GW, Ethylebenzene =2,600 ppb - GW, Xylenes =3,953 ppb - GW	

Primary hazards: Benzene = Flammable, harmful if swallowed, respiratory tract irritation, blood, bone, marrow, skin irritation, eye irritation, central nervous system depression. Etheylbenzene = Flammable, harmful if swallowed, respiratory tract irritation, skin irritation, eye irritation, central nervous system. Xylenes = Flammable, harmful if swallowed, respiratory tract irritation, skin irritation, eye irritation, central nervous system, blood, liver kidneys, gastrointestinal tract.		Exposure symptoms: Benzene = irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]. Ethylbenzene =irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma. Xylenes = irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis.	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**:
PEL: B=1 ppm, Eth/Xy=100 ppm	REL: B=0.1 ppm, Eth/Xy=100 ppm	TLV: Click here to enter text.	B=500 ppm, Ethyl=800 ppm, Xy=900 ppm
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV):
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	B=9.24, Ethyl=8.76, Xy=8.56
Material name: Naphthalene		Highest reported concentration*: 1,900 ppb - GW	
Primary hazards: inhalation, skin absorption, ingestion, skin and/or eye contact		Exposure symptoms: irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage	
OSHA Exposure Limits**	NIOSH Exposure Limits**	ACGIH Exposure Limits**	IDLH Level**:
PEL: 10 ppm	REL: 10 ppm	TLV: Click here to enter text.	250 ppm
STEL: Click here to enter text.	STEL: Click here to enter text.	STEL: Click here to enter text.	Ionization Potential (in eV):
Other: Click here to enter text.	Other: Click here to enter text.	Other: Click here to enter text.	8.12

For additional chemicals, refer to S3-NAM-029-FM9 (Additional Known or Suspected Chemicals of Concern).
*Specify units and sample medium; **Specify units
OSHA Permissible Exposure Limits (PEL) and Short Term Exposure Limits (STEL); https://www.osha.gov/dsg/annotated-pels/
NIOSH Recommended Exposure Limits (REL), STELs, and Immediately Dangerous to Life and Health (IDLH); http://www.cdc.gov/niosh/npg/
ACGIH Threshold Limit Values (TLV) and STELs; contact your Division H&S Leader for additional information on these values.

Personal Protective Equipment

Req = Required PPE for one or more tasks to be performed; required on site at all times. NA = Not applicable to this project.

Equipment	**Req**	**NA**	**Supplies**	**Req**	**NA**
Steel-toed Boots	☒	☐	Inner Chemical Gloves	☒	☐
Outer Disposable Boots	☐	☒	Outer Chemical Gloves	☒	☐

Long Sleeve Shirt/Pants	☒	☐	Leather or Kevlar Gloves	☒	☐
Tyvek Suit	☐	☒	Safety Glasses/Goggles	☒	☐
Poly-Coated Tyvek Suit	☐	☒	Face Shield	☒	☐
Fully Encapsulated Chemical Suit	☐	☒	Hearing Protection	☒	☐
Flame Resistant Clothing/Coveralls	☐	☒	Half-face Respirator	☒	☐
High Visibility Traffic Vest	☒	☐	Full-face Respirator	☐	☒
Hard Hat	☒	☐	If either half or full-face respirator checked:		
Other (specify): Click here to enter text.	☐	☐	• Define cartridge type: OV/P100 Particulate Filter • Define cartridge change frequency: Daily or per concentrations and manufacturer's recommendations		

Respirator selection should be based on the Assigned Protection Factor (APF) and the Maximum Use Concentration (MUC). To determine the appropriate respirator selection, the lowest appropriate published exposure guideline should be known. The Division H&S Leader or project H&S consultant can provide assistance in defining the APF and MUC, as necessary. They can also assist in defining actions levels and cartridge change schedules when air-purifying respirators are used. Note that cartridge change schedules must be outlined above and in the JHA for any task requiring respiratory protection.

Use of respiratory protection requires three elements: training in respiratory protection techniques, completion of medical surveillance confirming that you are fit to wear a respirator, and fit testing with the make and model of respirator you will be using. Refer to S3-NAM-026-PR (*Respiratory Protection*) for additional information.

Training, Medical Surveillance, and Safety Supplies					
Req = Required; requirements are based on the specific tasks performed in the field and the type of environments, chemicals, or hazards encountered. NA = Not applicable to this project.					
Training	**Req**	**NA**	**Medical Surveillance****	**Req**	**NA**
40-Hour Hazwoper	☒	☐	Medical Clearance	☒	☐
Current 8-hour Hazwoper Refresher	☒	☐	Respirator Clearance and Fit Test	☒	☐
8-Hour Hazwoper Supervisor*	☐	☒	Blood Lead and ZPP	☐	☒
Current First Aid/CPR	☒	☐	Other (specify): Click here to enter text.	☐	☐
40-Hour MSHA New Miner	☐	☒	Other (specify): Click here to enter text.	☐	☐
Current 8-hour MSHA Refresher	☐	☒	**Safety Supplies**	**Req**	**NA**
ERM Field Safety Officer (FSO)	☒	☐	First Aid Kit	☒	☐
DDD Practice FSO/DM	☐	☒	Eyewash Solution (15 minute flush)	☒	☐
Subsurface Clearance (SSC)	☒	☐	Air Horn	☐	☒
EPA Hazardous Waste	☒	☐	Decontamination Supplies	☒	☐
Hazmat/Dangerous Goods Shipping	☐	☒	Fire Extinguisher	☒	☐
International Traveler	☐	☒	Potable Water	☒	☐
Other (specify): Click here to enter text.	☐	☐	Toilets	☒	☐
Other (specify): Click here to enter text.	☐	☐	Other (specify): Click here to enter text.	☐	☐

*Provides specialized training to serve as an on-site manager supervising employees engaged in work covered by 29 CFR 1910.120.
**Physical examination requirements should be discussed with Workcare well in advance of project to allow adequate time to schedule exams.

Monitoring Equipment

All monitoring equipment on site must be calibrated per manufacturer specifications (including daily bump tests) and results recorded. Under stable conditions, measurements must be made in the breathing zone at least once every 30 minutes.

Combustible Gas Indicator	Reading	Action Guideline	Comments
Check if required: ☐	0 to 10% LEL	Monitor. Evacuate if confined space.	Click here to enter text.
Model: Click here to enter text.	10 to 25% LEL	Potential fire or explosion hazard.	
Task number(s): Click here to enter text.	>25% LEL	Fire/explosion hazard. Evacuate.	

Oxygen Meter	Reading	Action Guideline	Comments
Check if required: ☐	>23.5%	Fire hazard. Evacuate.	Click here to enter text.
Model: Click here to enter text.	23.5 to 19.5%	Normal oxygen levels.	
Task number(s): Click here to enter text.	<19.5%	Oxygen deficient conditions. Evacuate.	

Radiation Survey Meter	Reading	Action Guideline	Comments
Check if required: ☐	Normal background	Proceed with normal operations.	Annual exposure not to exceed 1250 mrem per quarter. Background reading must be taken in an area known to be free of radiation sources.
Model: Click here to enter text.	3x background	Notify Radiation Safety Officer.	
Task number(s): Click here to enter text.	>3x background	Radiological hazard. Evacuate.	

Photoionization Detector	Reading	Action Guideline	Comments
Check if required: ☒	Any response below 0.5 ppm, sustained for 1 minute	Level "D" PPE is acceptable up to the action level. For response above established background level(s), appropriate level PPE requirements must be met.	The action level for upgrading the level of protection is typically ½ the lowest published exposure limit for the potential COCs at the site. For COCs with extremely low exposure limits (e.g., <5 ppm), contact your Division H&S Leader for guidance on action levels. See end of this section for additional information on respirator selection.
Model: 2000 or 3000 Mini Rae with 10.6 eV lamp	0.5 ppm to 5 ppm, sustained for 1 minute	Level "C" is acceptable as appropriate.	
Task number(s): Click here to enter text.	Greater than 5 ppm above background, sustained for 1 minute	Stop work. Tasks requiring Level B or Level A PPE are not anticipated during this project. If Level B or Level A PPE is needed, as determined by the FSO and/or the PM, the Division H&S Leader will be notified and the HASP will be revised.	

Flame Ionization Detector	Reading	Action Guideline	Comments
Check if required: ☐	Any response below Click here to enter text. ppm, sustained for 1 minute	Level "D" PPE is acceptable up to the action level. For response above established background level(s), appropriate level PPE requirements must be met.	The action level for upgrading the level of protection is typically ½ the lowest published exposure limit for the potential COCs at the site. For COCs with extremely low exposure limits (e.g., <5 ppm), contact your Division H&S Leader for guidance on action levels. See end of this section for additional information on respirator selection.
Model: Click here to enter text.	Click here to enter text. ppm to Click here to enter text. ppm, sustained for 1 minute	Level "C" is acceptable as appropriate.	
Task number(s): Click here to enter text.	Greater than Click here to enter text. ppm above background, sustained for 1 minute	Stop work. Tasks requiring Level B or Level A PPE are not anticipated during this project. If Level B or Level A PPE is needed, as determined by the FSO and/or the PM, the Division H&S Leader will be notified and the HASP will be revised.	
Colorimetric Detector Tubes	**Reading**	**Action Guideline**	**Comments**
Check if required: ☐	Specify: Click here to enter text.	Specify: Click here to enter text.	Click here to enter text.
Model: Click here to enter text.			
Task number(s): Click here to enter text.			
Other (specify): Click here to enter text.	**Reading**	**Action Guideline**	**Comments**
Check if required: ☐	Specify: Click here to enter text.	Specify: Click here to enter text.	Click here to enter text.
Model: Click here to enter text.			
Task number(s): Click here to enter text.			

Work Zones ***Complete if exclusion zones are necessary because of chemical and/or equipment hazards. Describe the set-up of these zones. Include landmarks, dimensions (as necessary), and whether they are for equipment or personnel decontamination.***
Exclusion Zone: Exclusion zone to be set up at a 15 foot (min.) radius of equipment or work area using traffic cones and caution tape. Access will be monitored by site safety officer.
Contamination Reduction Zone: The contamination reduction zone will be immediately outside of the Exclusion zone but within the closed work area as convenient and appropriate.
Support Zone: The support zone will include the area outside of the exclusion zone.
Site Access/Control ***Describe procedures for limiting unauthorized entry to the work zone(s). Describe any security requirements.***
Access Control Procedures: Access to the site is controlled be the surrounding fence, the gate requires a code to enter, and will be monitored by the ERM FSO
Decontamination Procedures ***Describe procedures for the decontamination of personnel and equipment.***
Personnel: Decontamination involves the orderly controlled removal of contaminants from both personnel and equipment. The purpose of decontamination procedures is to prevent the spreading of contaminated materials into uncontaminated areas. All site personnel should limit contact with contaminated soil, groundwater, or equipment in order to reduce the need for extensive decontamination. Equipment and materials used in the decontamination process may include the following: High pressure/hot water cleaning using only potable water/fire water; Five-gallon bucket; Potable water; distilled water; Paper towles; and Brushes. All personnel must follow the appropriate order for cleansing and removal during decontamination: Boots, outer gloves, coveralls or protective suit, and inner gloves.

Equipment: The following will be required for equipment and tool decontamination: Before leaving the work area, excess contamination will be removed from the equipment and tools and placed in approved, properly labeled containers. A decontamination area will be designated for cleaning all equipment that has been in contact with the site materials before leaving the site. All decontamination will be conducted on a gravel filled pad with an impermeable synthetic liner and fluid-containment berm. Equipment will be placed on the pad and rinsed, brushed and/or steam cleaned to remove any contamination. Disposal of fluids generated from the decontamination process will be in accordance with approved work plans. Disposal of all solids collected within the decontamination pad and the pad liner will be in accordance with approved work plans. For major equipment, utilize a soap and/or water rinse and steam cleaning with temperature between 160 degrees to 180 degrees Fahrenheit with a pressure at or greater than 1,200 pounds per square inch (psi) will be the minimum required procedure. Trucks and equipment will use rumble strips, gravel, and/or truck baths to remove contaminants in the staging area.

Spill Prevention and Response ***Ensure all chemical containers on site are labeled and lids are secured when not in use. When transferring chemicals from one container to another, or when refueling vehicles or equipment, provide containment beneath the transfer point to capture potential spills. Immediately report all chemical spills to the PIC/PM and submit an ECS entry with 24 hours.***
Will ERM staff or ERM-hired contractors possess containerized chemicals on the project site? ☒ Yes ☐ No
Will container size be greater than or equal to one gallon? ☒ Yes ☐ No
If the answer to both of these questions is Yes, follow the requirements outlined in ERM Procedure S3-NAM-042-PR (*Spill Prevention and Response*)?
Waste Management Planning
Will ERM's project activities generate waste materials? ☒ Yes ☐ No
Will ERM undertake some level of contractual responsibility for handling waste for the client? ☒ Yes ☐ No
If the answer to either of these questions is Yes, follow the requirements outlined in ERM Procedure S3-NAM-038-PR (*Waste Management Planning*).
Describe any waste reduction/minimization techniques to be used on the site: Erosion control plan designs per ERMs "Southern PEO Groundwater Barrier Wall and Source Control Measures" plan, will be in place including but not limited to silt fences, stockpile covering, berm erection.
Client-Specific Emergency Response ***In the event of an emergency, client-specific emergency response procedures may take precedence over ERM established procedures.*** ***While engaging in field-related activities on an active client site, measures they have in place to signal either emergency response or evacuation need to be reviewed and documented.*** ***Once completed, this summary should be discussed with all visitors, contractors, and others subject to HASP review upon site visit.***
Contributing factor initiating emergency response (process, material, weather): N/A
Lights and/or sounds associated with evacuation: N/A
Drill requirements for contractors on-site: N/A
Initial and alternative muster points: To be determined onsite
Specific evacuation procedures: To be determined onsite
Method for accounting for site visitors: N/A

PPE and spill kit requirements (if emergency response is spill related): The spill contamination program for this project will involve the use of preventative measures in order to reduce the potential for environmental releases. These preventative measures will include the following: Equipment inspection, staging equipment on containment pads, secondary sontainment for fuel storage tanks, and general housekeeping practices If project activities involve the use of drums or other containers, the drums or containers will meet the appropriate DOT regulations and will be inspected and their integrity assured prior to being moved. Operations will be organized to minimize drum or container movement. Drums or containers that cannot be moved without failure will be over packed into an appropriate container.

Map associated with evacuation attached? ☐ Yes ☒ No

Emergency Contacts

All ERM employees are empowered to pause or stop work to address any unsafe acts/conditions, questions, concerns or changed conditions. All work-related safety events should be shared with the project team and promptly entered into the Event Communication System (ECS).

FOR ALL MEDICAL EMERGENCIES, CALL 911 OR THE LOCAL EMERGENCY NUMBER.

For ALL non-emergency incidents resulting in any injury or illness, you must:

- *Give appropriate first aid care to the injured or ill individual and secure the scene.*
- *Immediately notify the PM, PIC, and the H&S Team.*
- *At direction of PM, PIC, or H&S Team, call WorkCare Incident Intervention at (888) 449-7787 (available 24 hours/7 days per week in US only).*
- *Clients may have their own procedures which we may need to follow.*

For all incidents (injuries, illnesses, spills, fires, property damage, etc.) and significant near misses, enter the event into ECS within 24 hours.

Contact	Name	Location	Phone
Hospital (attach map)	Legacy Good Samaritan Medical Center	1015 Northwest 22nd Avenue, Portland, OR 97210	(503) 413-7753
Police	Portland City Police - Central	1111 SV 2nd Ave, Portland, Oregon 97204	(503) 823-3333 or 911
Fire	Portland Fire Station	3130 NW Skyline Blvd, Portland, Oregon 97229	(503) 203-0003 or 911
Incident Intervention	WorkCare	NA	888-449-7787
Partner-in-Charge	Erik Ipsen	Portland, Oregon	Work: (503) 488-5014 Cell: (503) 724-7998
Project Manager	Brendan Robinson	Portland, Oregon	Work: (503) 488-5011 Cell: (503) 310-8463

Field Manager (if not PM)	Kathryn Ewing	Portland, Oregon	Work: (971) 266-2566 Cell: (971) 330-5014
Field Safety Officer (if not PM)	Justin Dauphinais	Portland, Oregon	Work: (503) 488-2599 Cell: (503) 853-2468
SSC Experienced Person	Justin Dauphinais	Portland, Oregon	Work: (503) 488-2599 Cell: (503) 853-2468
Division H&S Contact	Brad Bishop	Sacramento, CA	Work: Cell: 916.752.7989
Region H&S Director	Steven Perkins	Irvine, CA	Work: 949-623-4700 Cell: 714-928-3608
Subcontractor Contact	Charlie Krug (DeWind) Direct Subcontractor to the client	Zeeland, MI	Work: 616-875-7580 Cell: 616-218-3298
Client Contact	Tom Graf	San Francisco, CA	Work: 415-290-5034 Cell: Click here to enter text.
Additional Contact	NRC (Emergency Spill Response)	United States	Work: 1-800-899-4672 Cell:

Acknowledgement

I have read, understood, and agree with the information set forth in this health and safety plan (HASP), and will follow guidance in the plan and in ERM's Document Control System (DCS). I understand the training and medical monitoring requirements (if any) for conducting activities covered by this HASP and have met these requirements.

ERM has prepared this plan solely for the purpose of protecting the health and safety of ERM employees. Contractors, visitors, and others at the site are required to follow provisions in this document at a minimum, but must refer to the organization's health and safety program for their protection.

Printed Name	Signature	Organization	Date

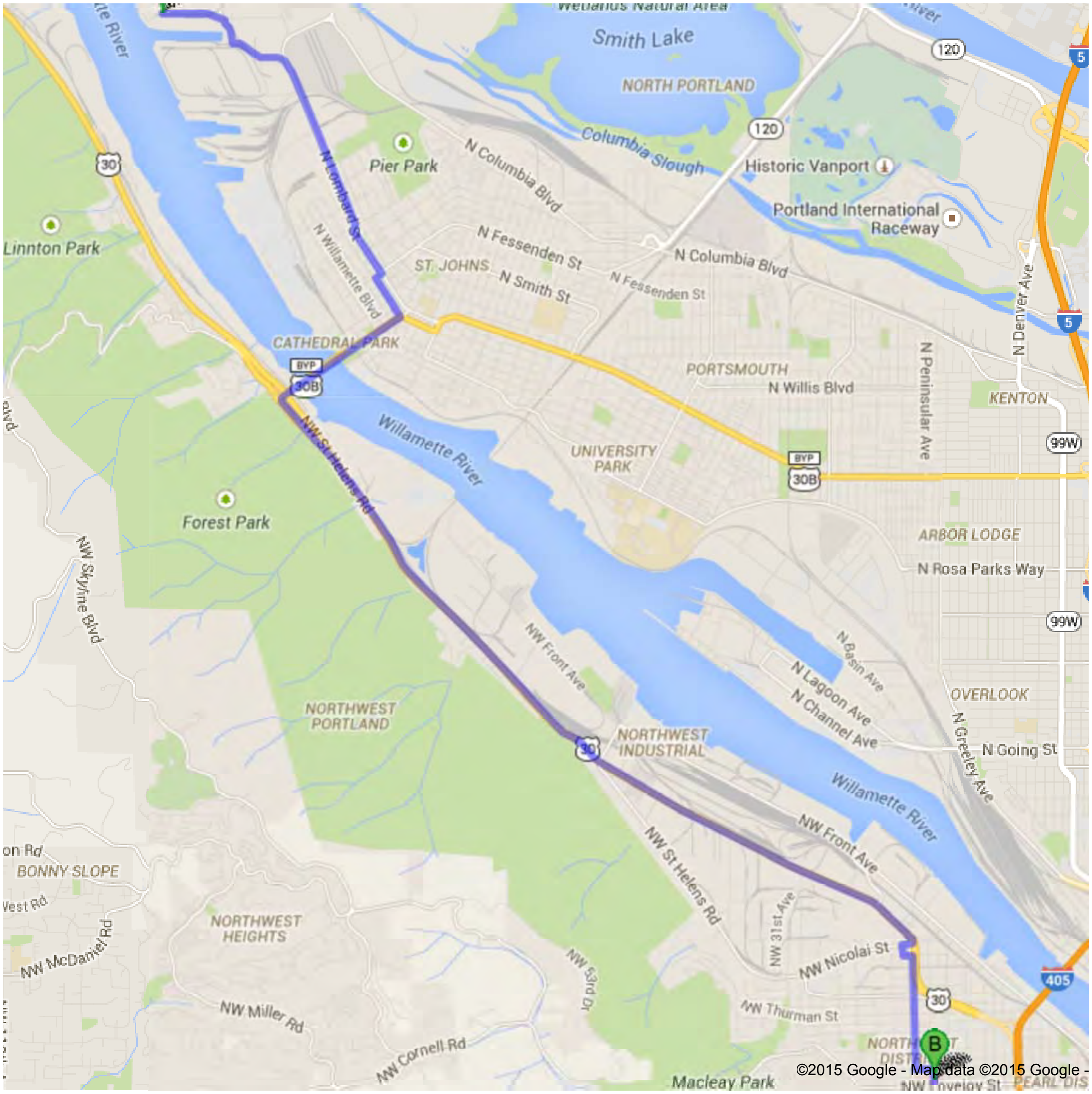
Approval Signatures ***Signatures in this section indicate the signing employee will comply with and enforce this HASP, as well as procedures and guidelines established in ERM's DCS. Signatures also indicate that any subcontractors performing work under contract to ERM have met the minimum safety standards in S3-NAM-030-PR (Contractor Management).***		**Project Manager**	**Date**
		Typed Name: Brendan Robinson Signature File:	Click here to enter a date.
		Partner-in-Charge	**Date**
		Typed Name: Erik Ipsen Signature File:	Click here to enter a date.

Attachments ***Check all appropriate documents to be attached to this HASP.***	
☒ Site-specific JHAs for all tasks (including contractors)	☒ Map of route to hospital with turn-by-turn instructions
☒ Subsurface Clearance (SSC) Project Plan	☒ Facility site map(s)
☒ Site Safety Meeting Form (S3-NAM-029-FM5)	☒ SNAP Cards
☒ Vehicle Inspection Forms (S1-ERM-008-FM2)	☒ Project/Field Audit Checklist (M1-ERM-016-FM3)
☐ Journey Management Plans (S1-ERM-008-FM1)	☐ Industrial Hygiene Sample Data (S3-NAM-005-FM1)
☒ Safety Data Sheets (SDS) for chemicals brought to site	☒ Ambient Air Monitoring Form (S3-NAM-005-FM2)
☐ Information on chemicals of concern (ICSC cards or like)	☐ Client-specific requirements
☐ PLAN Risk Assessment	☐ Other: Click here to enter text.
Applicable ERM Safety Standards/Procedures ***Check all that procedures/standards that are applicable to this project. Refer to the standards/procedures for guidance and, where applicable, use forms, work instructions, and guideline documents associated with these standards/procedures in the completion of site work. Copies of all standards/procedures must be procured from ERM's Document Control System.***	
Global (Tier I) Standards/Procedures	
☒ Short Service Employees (S1-ERM-003-PR)	☐ Travel Risk Assessment (S1-ERM-005-ST)
☐ Offshore Platform Safety (S1-ERM-006-ST)	☒ Subsurface Clearance Standard (S1-ERM-007-ST)
☒ Driver and Vehicle Safety (S1-ERM-008-PR)	☐ Fixed Wing Aircraft/Helicopter Travel (S1-ERM-009-ST)
Local (Tier III) Standards/Procedures	
☐ Demolition (S3-NAM-004-PR)	☒ Excavation and Trenching (S3-NAM-008-PR)
☐ Fall Protection (S3-NAM-009-PR)	☒ Setting Occ. Exposure Guidelines (S3-NAM-010-PR)
☒ Hazard Communication (S3-NAM-011-PR)	☒ Hearing Conservation (S3-NAM-014-PR)
☒ Heat and Cold Stress (S3-NAM-015-PR)	☒ Incident Reporting/Investigation (S3-NAM-016-PR)
☒ Medical Services (S3-NAM-019-PR)	☒ Medical Surveillance (S3-NAM-020-PR)
☒ Personal Protective Equipment (S3-NAM-021-PR)	☐ Process Safety Management (S3-NAM-022-PR)
☐ Regulatory Inspection (S3-NAM-024-PR)	☒ Reproductive Hazards (S3-NAM-025-PR)
☒ Respiratory Protection (S3-NAM-026-PR)	☒ Contractor Management (S3-NAM-030-PR)
☒ Short Service Employees (S3-NAM-034-PR)	☒ Electrical Safety (S3-NAM-035-PR)
☐ NORM-TENORM (S3-NAM-036-PR)	☒ Incident/Illness Management (S3-NAM-037-PR)
☒ Waste Management Planning (S3-NAM-038-PR)	☐ Energy Isolation (S3-NAM-039-PR)
☒ Spill Prevention and Response (S3-NAM-042-PR)	☐ Fatigue Management (S3-NAM-044-PR)
☐ Commercial Motor Vehicles (S3-NAM-045-PR)	☐ Emergency Response Operations (S3-NAM-046-PR)
☒ Cutting Tools and Hand Safety (S3-NAM-047-PR)	☐ Lone Worker (S3-NAM-048-PR)
☐ Compressed Gas Cylinders (S3-NAM-049-PR)	☐ Fleet Management (S3-NAM-050-PR)

See It; Own It; Share It	Stop Work Authority
It means that: • **We know that we have a responsibility to look out for each other, to intervene when necessary, to be proactive and to help keep safety issues from becoming problems.** • **We also look out for ourselves. If we recognize that a situation is unsafe, we are expected to stop what we're doing, reassess the situation and consult with others if necessary before proceeding safely.** • **We assign no blame to anyone who raises safety issues.** • **We strive to learn lessons from the large and small events that are part of our daily experience.**	**It is ERM policy that all ERM and ERM Contractor employees have the authority, without fear of reprimand or retaliation to:** • **Immediately stop any work activity that presents a danger to the site team or the public.** • **Get involved, question and rectify any situation or work activity that is identified as not being in compliance with the HASP or with broader ERM health and safety policies.** • **Report any unsafe acts or conditions to supervision or, preferably, intervene to safely correct such acts or conditions themselves.**

THIS PAGE INTENTIONALLY LEFT BLANK

Directions to Legacy Good Samaritan Medical Center
1015 Northwest 22nd Avenue, Portland, OR 97210
8.6 mi – about **19 mins**



THIS PAGE INTENTIONALLY LEFT BLANK

A 10400 N Burgard Way, Portland, OR 97203

	1. Head **east** on **N Burgard Way** Partial restricted usage road About 48 secs	go 0.3 mi total 0.3 mi
	2. Turn right onto **N Sever Rd**	go 0.1 mi total 0.5 mi
	3. Turn left to stay on **N Sever Rd** About 1 min	go 0.4 mi total 0.8 mi
	4. Turn right onto **N Lombard St** About 3 mins	go 1.2 mi total 2.0 mi
	5. Turn right onto **N Saint Louis Ave**	go 262 ft total 2.1 mi
	6. Take the 1st left onto **N Ivanhoe St** About 57 secs	go 0.2 mi total 2.3 mi
	7. Turn right onto **N Philadelphia Ave**	go 0.4 mi total 2.7 mi
	8. Continue onto **NW St Johns Bridge**	go 0.4 mi total 3.1 mi
	9. Slight left to stay on **NW St Johns Bridge**	go 144 ft total 3.1 mi
	10. Slight left onto **NW Bridge Ave** About 54 secs	go 0.6 mi total 3.7 mi
	11. Turn right onto **NW St Helens Rd** About 3 mins	go 2.0 mi total 5.7 mi
30	12. Continue onto **U.S. 30 E/NW Yeon Ave** Continue to follow U.S. 30 E About 3 mins	go 1.9 mi total 7.6 mi
	13. Turn right onto **NW Nicolai St**	go 430 ft total 7.7 mi
	14. Turn left onto **NW 23rd Pl**	go 292 ft total 7.8 mi
	15. Take the 1st left onto **NW Reed St**	go 266 ft total 7.8 mi
	16. Turn right onto **NW 23rd Ave** About 2 mins	go 0.6 mi total 8.4 mi
	17. Turn left onto **NW Northrup St**	go 0.1 mi total 8.5 mi
	18. Turn right onto **NW 22nd Ave** Destination will be on the right	go 351 ft total 8.6 mi

B **Legacy Good Samaritan Medical Center**
1015 Northwest 22nd Avenue, Portland, OR 97210

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Directions weren't right? Please find your route on maps.google.com and click "Report a problem" at the bottom left.

THIS PAGE INTENTIONALLY LEFT BLANK

JHAs

THIS PAGE INTENTIONALLY LEFT BLANK

ERM

JHA
Job Hazard Analysis

Project Number:	283866	Project / Client Name:	Subsurface Investigation / MMGL
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way, Portland, Oregon
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Vehicle Inspection and Safe Driving Guidance**

Minimum Required PPE for Entire Task:	☐ Hard Hat ☑ Safety-Toe Shoes ☐ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☑ Safety Glasses ☑ Reflective Vest ☑ Gloves Cut resistant, rubber, nitrile ☐ PPE clothing <enter type here (eg, Tyvek, FRC, long sleeves)> <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)	None	Equipment / Tools Required:	Vehicle
Training Required for this Task:	Valid Drivers License	Permits Required for this Task:	
Forms Associated with This Task:	ERM Vehicle Safety Form		

JHA Developed / Reviewed By:			JHA Review In Field
Name / Job Title:	Name / Job Title:	Name / Job Title:	Field Safety Officer (FSO) to ensure all personnel performing this task have reviewed JHA and agree to follow it. Site-specific changes to this JHA have been made as warranted based on this review. **FSO Signature/Date:**
Justin Dauphinais / Project Geologist			

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
1a	Pre-Trip - Creating a Journey Management Plan (JMP). Consider worst case outcome of vehicle operation (blowout, breakdown, collision, slippery surfaces, injury, or death).	1a	N/A	multiple				1a	Create a JMP to familiarize yourself with the travel route, alternative routes, and route conditions. Assess potential hazards and analyze how to reduce the risk. Act to ensure safe operation of the vehicle and avoid all distractions from driving. Follow all posted signs, speed limits, and safe driving practices.
2a	Performing a vehicle inspection including a perimeter walk around vehicle for damage or unusual conditions.	2a	Slips-trips-falls. Pinched finger/hand. Cuts/scrapes to body. Natural hazards - bites/stings causing illness.	H&S	2	3	6	2a	"Look before touching vehicle, look under vehicle from safe distance. Use Vehicle Safety Form to inspect and document condition of the vehicle. • Assure all tires (including spare) are properly inflated and there is sufficient tread. • Assure there are no cuts or bulges in the sidewalls of all tires. • Assure windshield and window glass is clean. Lift wiper arms and check wiper blades for damage or deterioration. • Perform a 360 degree check in front of, behind, left, right, underneath, and above vehicle for obstructions, protrusions, evidence of fluid leaks, • Do not touch sharp metal edges. • Scrape windows, front, and rear windshields. For ERM-owned vehicles and vehicles used on the job site for work, complete and document daily vehicle inspection and report any vehicle safety issues to ERM Project Manager BEFORE driving vehicle. Secure all equipment and loose items.
3a	Checking and adjusting seat, mirrors, headlamps, tail lights, turn signals, washer/wipers, horn, and engine fluids.	3a	Discomfort while driving the vehicle, or inability to clearly see out of the vehicle could result in a collision and bodily injury or death. Mechanical failure due to lack of engine fluids could cause collision or being stranded. Personnel could be seriously injured.	multiple	2	5	10	3a	Assure engine fluids are at sufficient levels. Adjust seat so back is fully supported, upper arms close to body, and pedals within easy reach. Lower steering wheel so hands are below shoulders and shoulders are relaxed. Check mirror adjustments each time vehicle is re-started.
4a	Checking heater, defroster, gauges, and warning lights.	4a	Overheated engine or break-down due to lack of critical fluids. Brake failure causing collision and injury or death. Critical failure resulting in being stranded.	multiple	2	5	10	4a	Assure there is sufficient gas, oil, and other critical fluids.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
5a	Fastening seat belts.	5a	Collision with steering wheel or windshield which could greatly increase the bodily injury sustained in a collision. Violent and/or abrupt change of direction in cabin causing bodily injury.	multiple	2	5	10	5a	Assure seat belt is in good condition and fastened. Ensure all passenger seat belts are in good condition and fastened.
6a	Locking doors.	6a	Ejection from vehicle in collision increasing bodily injuries. Unwanted intrusion.	multiple	2	5	10	6a	Lock all doors to vehicle.
7a	Ensuring someone has walked around the vehicle immediately prior to driving away from parking spot. Turning off/securing cell phone and pulling out of parking space.	7a	Collision with other vehicles, pedestrians, or stationary objects causing bodily injury to self or others.	multiple	2	4	8	7a	Turn off or put away cell phone. Check mirrors and over shoulder in all directions prior to pulling out of parking space. Signal if parallel parked along a street.

JHA
Job Hazard Analysis

Project Number:	283866	Project / Client Name:	Subsurface Investigation / MMGL
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Alert Driving and Vehicle Operation**

Minimum Required PPE for Entire Task:	☐ Hard Hat ☐ Safety-Toe Shoes ☐ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☐ Safety Glasses ☐ Reflective Vest ☐ Gloves <enter type here> ☐ PPE clothing pants, long sleeves (eg, Tyvek, FRC, long sleeves)> <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)	None	Equipment / Tools Required:	Vehicle
Training Required for this Task:	Valid Drivers License, Alert Driving Training	Permits Required for this Task:	
Forms Associated with This Task:	ERM Vehicle Safety Form		

JHA Developed / Reviewed By:			JHA Review In Field
Name / Job Title:	Name / Job Title:	Name / Job Title:	Field Safety Officer (FSO) to ensure all personnel performing this task have reviewed JHA and agree to follow it. Site-specific changes to this JHA have been made as warranted based on this review. **FSO Signature/Date:**
Justin Dauphinais / Project Geologist			

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
1a	Inspecting the vehicle.	1a	Malfunctions with tire pressure, the brakes, steering, headlights, tail lights, and other vehicle equipment in addition to evidence of fluid leaks below the vehicle can contribute to property damage and/or vehicular accidents (injury or death).	multiple	2	5	10	1a	Use the ERM Vehicle Safety Form to document daily inspections of the vehicle. Do not operate any vehicle if its safety is in question and report any vehicle safety issues to ERM the Project Manager before driving vehicle. See Vehicle Inspection JHA.
1b		1b	Loose articles inside the vehicle and carried in truck beds or on trailers can shift and cause distractions, property damage, and/or vehicular accidents (injury or death).	multiple	2	5	10	1b	During the vehicle inspection make sure any loose articles either inside the vehicle or in truck beds/on trailers are well-secured. For trailers, ensure trailers are properly and securely attached to hitch.
2a	Entering and exiting as well loading and unloading the vehicle.	2a	Hands, hair, or loose clothing or equipment can be caught in doors, trunk covers, and other vehicle equipment, causing injury. Muscle strains; pinch points; slips, trips, and falls; and equipment damage could occur during loading and unloading of vehicle.	multiple	2	3	6	2a	When entering, exiting, loading, and unloading the vehicle, keep aware of: • Hands and feet placement and body posture (especially back and neck) to avoid slips, trips, falls, strains, sprains, and pinch points and • loose articles of clothing or equipment that can be caught in the vehicle door. ERM has had incidents occur simply from being rushed and not paying attention during vehicle entry, exit, loading, and unloading. Only carry what can safely be transported to/from the vehicle. Make as many trips as necessary, use a dolly/cart to transport items, and/or get assistance from another person.
3a	Driving.	3a	Operating a vehicle presents many different hazards to employees that must be simultaneously mitigated. A vehicle collision can result in property damage, injury, and/or death.	multiple	2	5	10	3a	Only allow ERM employees to drive motor vehicles (authorized employees with a current drivers license). Before driving, fasten seat belts. Ensure all loose items and equipment inside the vehicle or in truck beds/on trailers are secured and any electronics are programmed (GPS). Follow designated travel routes, all posted speed limits, and all posted signs. Do not pick up hitch-hikers and never transport people in truck beds. Turn on headlights when windshield wipers are used in rainy conditions. Avoid all forms of distracted driving.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
		3b	Driving larger vehicles or operating heavy equipment can result in a collision, injury, or death to occupants or other parties.	multiple	2	5	10	3b	Use spotter when driving large trucks or heavy equipment onto project sites, and for all vehicles when maneuvering in/out of tight spaces and backing up. Employees driving ERM trucks or pulling trailers must first receive training and authorization from BU Fleet Manager. Make sure vehicle is capable of pulling the weight of the trailer and its contents. Inspect the trailer to ensure brakes and turn signals work properly and are in concert with the main vehicle's signals, and tire pressure is acceptable. Ensure trailer is attached securely to the main vehicle and the safety chain or other backup attachment device is in-place. Evenly distribute weight on any trailers pulled. Turn off engine, set parking brake, and chock tires for larger vehicles and when parking on inclines.
4a	During the journey, continually scanning the road.	4a	Collision, injury, or death to occupants or other parties.	multiple	2	5	10	4a	Move eyes at least every 2 seconds. Scan major and minor intersections before entry (left-right-left). Check mirrors when slowing or stopping vehicle. Scan mirrors frequently, at least one mirror every 5-8 seconds. Avoid staring while evaluating road conditions. Maintain adequate spacing between your vehicle and the vehicle in front of you (Rule of thumb – one second for every 10 miles per hour, double the distance during poor road conditions). Try to anticipate hazards. Make eye contact with other drivers and pedestrians prior to moving from a full stop at an intersection and especially in a high-traffic area (city driving). Use turn signals. Watch for ice on road, slow down before hitting the ice, and keep your foot off the brake.
5a	Aiming high while steering.	5a	Collision, injury, or death to occupants or other parties.	multiple	2	5	10	5a	Maintain 15 second eye lead time (1 1/2 blocks in city traffic, 1/4 mile in highway traffic). Assess condition of traffic lights (fresh vs. stale). Assess information from distant objects. Adjust eye lead distance to speed. Watch for ice on road, slow down before hitting the ice, and keep your foot off the brake.
6a	Backing up.	6a	Collision, injury, or death to occupants or other parties.	multiple	2	5	10	6a	Make all backing maneuvers slowly and cautiously. Check mirrors and over shoulders. When parking, look for pull-through parking or back into parking spot when safe to do so. If possible, use a spotter.
7a	Parking.	7a	Collision, injury, or death to occupants or other parties.	multiple	2	4	8	7a	Park away from other cars. Back into parking spot when possible. Maintain cushion of safety from fixed objects. Always set parking brake. Look for pull-through parking to avoid backing. When parking on an incline, turn the wheels away from the curb and allow the vehicle to roll back until the wheels touch the curb. On a decline, turn the wheels toward the curb and allow the vehicle to roll forward until the wheels touch the curb. If parking on a hill without a curb, park with the wheels turned away from the roadway.
8a	Fatigued driving.	8a	Operating a vehicle after a full day of work or when fatigued drastically decreases focus and response time and increases the risk of being involved in a vehicular accident which could result in property damage, injury, or death.	multiple	2	5	10	8a	Avoid driving more than 8 hours in one workday. If the number of hours driving to/from a jobsite combined with the number of hours to be worked on the site will equal more than 14 total hours, alternate arrangements should be arranged. Be aware of your fatigue level while driving and stop to rest if you feel overly tired. • Take a 15 minute break after every 2 hours of driving. • Not drive after more than 12 hours of work. • Avoid driving between 10pm and 5am. • Share driving with others, if possible. • Avoid driving after consecutive 14 hour work days. • Avoid driving after a 6 hour flight or more without appropriate rest. If feeling tired, pull over to a safe area and take a break. If any doubts get a hotel room or take the vehicle home if it shortens the commute.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
9a	Staying focused on the road.	9a	Doing anything that distracts from the road highly increases the risk of being involved in a vehicular accident. Mobile phone use, eating/drinking, and even talking can create distractions that could result in an accident (property damage, injury, or death).	multiple	2	5	10	9a	Do not operate a hand-held or hands-free mobile phone while driving. All mobile phone use while driving is prohibited by ERM and our clients. Do not perform activities while driving that will take one's attention from the road. A few of these types of activities could include programming GPS systems, applying makeup, changing the radio, or eating while driving. When these sorts of activities must be performed, pull to the side of the road and stop.
10a	Leaving the vehicle.	10a	Leaving personal valuables and company equipment/documents in abandoned vehicles may attract thieves and result in theft and/or property damage.	S	2	3	6	10a	Turn off the engine and lock any vehicle being left for even a short period of time when not on a secure jobsite. If the vehicle will be left for long periods or overnight, remove any company documents, computers, and equipment, personal valuables, or any items that would attract thieves.
11a	Reporting and documenting vehicular accidents and property damage.	11a	Improper documentation of vehicular accidents and property damage caused by vehicle operation place ERM at risk.	multiple	2	3	6	11a	No matter how minor a vehicle accident or property damage event is, report it as a safety event. If involved in a vehicular accident, always call the police, so a report will be available. In addition, reporting will protect your liability and ERM liability. Take as many pictures as you can of the accident scene if you can do so without placing yourself in further danger.
12a	Renting a vehicle.	12a	Only certain car rental agencies have negotiated contracts, rates, and insurance coverage with ERM. Renting a vehicle from another agency exposes you and ERM to unnecessary liability and risk.	multiple	2	3	6	12a	If possible, rent vehicles using the Concur online booking tool and from an ERM authorized car rental agency. If not possible to rent from either, you must purchase collision damage and personal accident insurance at the time of rental. Currently, authorized rental car agencies include: • Enterprise Car Rental • Hertz Car Rental

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
13a	Driving the vehicle near and across railroad tracks.	13a	Passing trains cannot stop quickly, and there is a risk for collisions resulting in property damage, injury, and death.	multiple	2	5	10	13a	Use caution when crossing any railroad track in a vehicle and do so only on designated crossing roads. Never come to a stop on RR tracks.
14a	Post-Trip - Reporting maintenance or mechanical problems upon returning vehicle.	14a	Unreported maintenance or mechanical problems can worsen and lead to mechanical failure resulting in accident, injury, or death.	multiple	2	5	10	14a	Report vehicle problems immediately to company representative. Take vehicle to get fixed if out of town. Do not continue using vehicle that is not mechanically sound.

JHA
Job Hazard Analysis

Project Number:	283866	Project / Client Name:	Subsurface Investigation / MMGL
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Mark borehole and excavation locations for Oregon One Call Utility Notification Center locate**

Minimum Required PPE for Entire Task:	☑ Hard Hat ☑ Safety-Toe Shoes ☑ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☑ Safety Glasses ☑ Reflective Vest ☑ Gloves Cut resistant, rubber, nitrile ☐ PPE clothing <enter type here (eg, Tyvek, FRC, long sleeves)> <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)		Equipment / Tools Required:	Tape measure, measuring wheel, white marking paint
Training Required for this Task:	40-hour HAZWOPER, 8-hour refresher training, FSO, SSC EP	Permits Required for this Task:	
Forms Associated with This Task:	Site Map with proposed SSC locations - SSC Project Plan		

JHA Developed / Reviewed By:			JHA Review In Field
Name / Job Title:	Name / Job Title:	Name / Job Title:	Field Safety Officer (FSO) to ensure all personnel performing this task have reviewed JHA and agree to follow it. Site-specific changes to this JHA have been made as warranted based on this review. **FSO Signature/Date:**
Justin Dauphinais / Project Geologist			

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
1a	Site Access	1a	Unable to access gated site causing delay in work.	S	2	2	4	1a	Communicate with Client and Site Contact to determine access issues prior to leaving for site. Use JMP to plan travel. Park in secure, designated area. If working alone, follow communication plan for checking in with Supervisor or designee. Procure gate key for week long operations.
2a	Site walk	2a	Site workers or natural hazards causing interference with work, slips-trips-falls resulting in physical injury.	H&S	2	4	8	2a	Don all required Level D PPE. Review site plan and acquire a sense of direction. Look around for any potential security issues and stop work if such hazards exist. Cross areas at designated locations when possible. Always look where you are walking, do not attempt to read the map or site plan and walk at the same time. Take the path of least resistance, avoid taking shortcuts that may posses additional STF hazards. Examine area for subsurface utility indicators. Stop work and contact PM/PIC if any issues are observed.
3a	Verifying proposed SSC locations	3a	Site workers or natural hazards causing interference with work, slips-trips-falls resulting in physical injury.	H&S	2	4	8	3a	Do not enter active traffic patterns/roads without spotter. Verify that proposed locations are free of overhead hazards and provide adequate access for vehicles/equipment/personnel to perform the planned tasks. Always look where you are walking, do not attempt to read the map or site plan and walk at the same time. Examine area for subsurface utility indicators. Examine area for subsurface utility indicators. Stop work and contact PM/PIC if any issues are observed.
4a	Mark OCUNC location areas for SSC locations	4a	Site workers or natural hazards causing interference with work, slips-trips-falls resulting in physical injury.	H&S	2	4	8	4a	Do not enter work areas patterns/roads without spotter. Verify that proposed locations are free of overhead hazards and provide adequate access for vehicles/equipment/personnel to perform the planned tasks. Always look where you are walking, do not attempt to read the map or site plan and walk at the same time. Examine area for subsurface utility indicators. Stop work and contact PM/PIC if any issues are observed.
		4b	Inhalation of spray paint, dermal contact, eye contact causing bodily injury or illness.	H&S	2	3	6	4b	Wear appropriate gloves along with Level D PPE. Use paint dispenser whenever possible which will prevent bending and reaching for the ground. Follow manufactures reccomendations listed on paint can. Stand upwind whenever possible to avoid paint mist in air. Wash hands and any skin containing paint if necessary.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
5a	Leaving the site	5a	Site workers or natural hazards causing interference with work, slips-trips-falls resulting in physical injury.	H&S	2	4	8	5a	Look around for any potential security issues prior to walking back to vehicle or loading vehicle, and stop work if such hazards exist. Cross ares at designated locations when possible. Take the path of least resistance, avoid taking shortcuts that may posses additional STF hazards. If working alone, contact PM or designee to communicate your status and intentions.

JHA
Job Hazard Analysis

Project Number:	283866	Project / Client Name:	Subsurface Investigation / MMGL
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Oversight of Subsurface clearance for ground-penetrating activities**

Minimum Required PPE for Entire Task:	☑ Hard Hat ☑ Safety-Toe Shoes ☐ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☑ Safety Glasses ☑ Reflective Vest ☐ Gloves <enter type here> ☐ PPE clothing <enter type here (eg, Tyvek, FRC, long sleeves)> <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)	None	Equipment / Tools Required:	Flags, delineators, marking paint, survey stakes.
Training Required for this Task:	40-hour HAZWOPER, 8-hour refresher training, Experienced Person (EP) certfication, FSO	Permits Required for this Task:	USA ticket
Forms Associated with This Task:	Subsurface clearance checklist, USA ticket number, EP Mentorship Card (for non-EP ERM personnel), SSC Project Plan		

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
1a	Identify a Client Contact Person	1a	Client contacts that are not familiar with the site layout could cause critical information to be missed during safety planning.	H&S	3	2	6	1a	Determine degree of knowledge of our client contact by evaluating their current job duties at the site, length of time they have worked at the site, and time in their current job. If the ERM team does not feel comfortable with the level of experience of our client contact, take additional measures to ensure all pertinent subsurface utilities and services information is gathered.
2a	Engage Subcontractors	2a	Subcontractors who have not been evaluated against ERM minimum safety standards or who do not meet minimum safety standards may pose more risk	H&S	3	2	6	2a	Use only ERM subcontractors who are identified as having met our minimum safety standards. In cases where using an already-qualified subcontractor is not possible, ensure extra precautions are taken to provide safety oversight to the work.
3a	Appoint an ERM Subsurface Clearance "Experienced Person" to the project	3a	ERM employees who are not experienced with SSC issues may not recognize critical zones or clues to other site utilities/services.	H&S	3	2	6	3a	Ensure a "SSC Experienced Person" is assigned to the project to provide oversight of ground penetrations and to mentor less experienced ERM employees.
4a	Gather site-specific subsurface information	4a	Incomplete or inaccurate site utility/service drawings may lead the ERM project team to incorrect conclusions regarding what utilities/services are onsite	H&S	3	2	6	4a	Obtain the most recent "as-built" drawings and additional site information such as easements, rights-of-way, historical plot plans, etc. to assist making decisions about other actions that will be required at the site.
5a	Develop the HASP	5a	Using incorrect documents in safety planning may lead to not considering all pertinent information.	H&S	3	1	3	5a	A Level 2 WARN HASP for Intrusive Work (minimum) must be used when performing any ground penetrations, with the exception of surface soil sampling. The Level 2 HASP contains a "Site Services Model" that ERM uses to evaluate SSC hazards.
6a	Develop the Site Services Model	6a	Critical zones and a whole-site view of utilities and services at the site are more difficult to do if not put into the Site Services Model	H&S	3	1	3	6a	Use the Site Services Model to identify gaps in knowledge from all drawings and other verbal information from our client contact. Identify locations of key isolation and shutoffs closest to the work area for each type of utility/service.
7a	Make Preliminary Determinations	7a	Not recognizing or identifying critical zones poses great hazard to ERM employees in the field from contact with electricity or other utilities	H&S	3	2	6	7a	Establish critical zones and excavation buffers (if needed) for the work. Initial critical zone determinations may change in the field but are a good starting point in hazard identification.
8a	Identify Preliminary Ground Disturbance Locations	8a	Planning ground disturbance locations inside critical zones poses great hazard to ERM employees in the field from contact with electricity or other utilities	H&S	3	3	9	8a	Ensure critical zones have been identified using the Site Services Model and then identify locations outside those critical zones up-front, if possible. If a ground disturbance inside a critical zone is absolutely necessary, notify the site PIC and obtain guidance from him/her before proceeding.
9a	Public and/or Private Utility Markout	9a	Not having utilities marked may lead to a subsurface clearance strike which could lead to a serious injury or death.	multiple	3	3	9	9a	Contact public and private utility markout services giving them enough time to respond. A minimum of 24-hour notification to utility locators is required in most states, and may vary higher in some states.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
10a	Conduct the Site Walk	10a	Inexperienced people conducting the site walk may miss pertinent information regarding utilities and/or services.	H&S	3	1	3	10a	The “SSC Experienced Person” must lead the site walk and should be accompanied by our client contact. Each ground disturbance location should be approved by our client contact (written approval preferred, verbal approval acceptable).
						2			
11a	Inspect Each Ground Disturbance Location	11a	Inexperienced people conducting inspection may miss pertinent information regarding utilities and/or services.	H&S	3	2	6	11a	The “SSC Experienced Person” must lead inspection of each Ground Disturbance Location. Any visual clues of subsurface obstruction/utilities should be documented. Critical zones may have to be reassessed at this point. Use the SSC Checklist to document this inspection for each point inside a critical zone, at a minimum.
12a	Finalize Critical Zone Determinations	12a	Not performing this verification step in the field may lead to a SSC strike. This could result in serious injury or death.	multiple	3	3	9	12a	Use information gathered during pre-planning, utility markout, and site walk/inspection to verify critical zones that have been previously established. Revise critical zones as necessary. Use the SSC Checklist to document points inside critical zones. If points are confirmed inside critical zones, either step out and relocate the ground disturbance location, or contact the PIC for additional guidance.
13a	Physically Clear all Ground Disturbance Locations	13a	Employees performing physical clearance could contact underground utility/service lines. This could cause serious injury or death	multiple	3	3	9	13a	Use cable avoidance tools at each location that must be physically cleared (OSHA requirement). If using a hand-auger, ensure insulated handles are in-place before their use.

JHA
Job Hazard Analysis

Project Number:	283866	Project / Client Name:	Subsurface Investigation / GW Barrier Wall Installa / MMGL
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Oversight of Heavy Equipment Operations** - Guidelines for working around heavy equipment.

Minimum Required PPE for Entire Task:	☑ Hard Hat ☑ Safety-Toe Shoes ☑ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☑ Safety Glasses ☑ Reflective Vest ☑ Gloves <enter type here> ☐ PPE clothing Long pants and long sleeve shirts <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)	High-visibility safety vest - Vest worn by equipment operators and those working in the area impacted by moving machinery	Equipment / Tools Required:	None
Training Required for this Task:	Heavy Equipment Operation - Operators must be trained and/or have demonstrated experience for each type of heavy equipment they will operate.	Permits Required for this Task:	None
Forms Associated with This Task:	Heavy Equipment Inspection form - Form for documenting daily heavy equipment inspections		

JHA Developed / Reviewed By:			JHA Review In Field
Name / Job Title:	Name / Job Title:	Name / Job Title:	Field Safety Officer (FSO) to ensure all personnel performing this task have reviewed JHA and agree to follow it. Site-specific changes to this JHA have been made as warranted based on this review. **FSO Signature/Date:**
Justin Dauphinais / Project Geologist			

Task Steps[1]		**Potential Hazards & Consequences**[2]		select	**Likelihood**	**Severity**	**RISK**	**Controls to Eliminate or Reduce Risks**[3]	
1	Offsite Preparation	1	Untrained workers operating heavy equipment pose potential life-threatening hazards to employees.	multiple	3	4	12	1	ERM policy and practice is that our employees do not operate heavy equipment except in unusual circumstances. If ERM personnel are to operate heavy equipment, this must be stated in the health and safety plan for the project. Only employees with training and/or demonstrated experience operating heavy equipment may do so. Subcontractor personnel operating heavy equipment must be trained and/or have demonstrated experience operating such equipment. ERM must be in possession of evidence of training and/or experience prior to Subcontractor personnel operating such equipment. All heavy equipment must meet applicable design standards (ANSI, etc.). A copy of the operating manual must be carried on all heavy equipment, including a load-rating chart and any special operating considerations.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
2	Heavy Equipment Operation	2a	Injury to operator and those in immediate vicinity from strikes with heavy equipment.	multiple	3	4	12	2a	Before starting operations, operators must ensure no one is working on or near machinery. If equipment is to be operated in close proximity to other workers, a spotter must be working in tandem with the operator. All heavy equipment must be inspected daily to ensure good working order. Critical safety items, such as brakes, backup alarms, horns, etc. must be in working order. Machinery with critical safety items in disrepair may not be used until they are fixed. Operators must operate equipment while wearing seatbelts, if provided, and at reasonable speeds. Mounting/dismounting a moving machine is prohibited. Do not transport personnel or equipment in machinery not designed for this purpose. Overhead obstructions must be assessed before operating machinery. If equipment is to be operated in close proximity to overhead obstructions, a spotter must be working in tandem with the operator. Safe working distances must be specified in the health and safety plan or JHA supplied by the subcontractor.
		2b	Spill from heavy equipment could cause a release creating environmental impacts to the site and surrounding area.	E	3	4	12	2a	Use funnel when pouring liquid for any operations involving chemicals. Ensure bleed valves are open and lines are clear prior to disconnect and/or use dry couplings. Have the appropritate absorbent material on hand included in the spill kit. (determined by subcontractors HASP) Place container and/or absorbent/plastic sheeting under connection prior to disconnect. Store hazardous materials in dedicated container/area Inspect pressurized lines and all fittings/couplings to ensure integrity/closure. Assess rating and compatibility of materials used vs purpose. Ensure storage compatibility of multiple products. Hazard Communication: For each chemical product used by ERM employees or subcontractors, a MSDS sheet must be obtained and kept on-file. Chemical containers must be labeled in accordance with OSHA regulations. Review MSDS and container label prior to start of task/handling and follow associated requirements. Ensure all employees on the jobsite have been told about the chemical in-use and are protected. Confirm MSDS is relevant when working with legacy material (e.g. historic releases). A chemical inventory list must be prepared and updated as new or different chemicals are procured. Lay down visqueen or plastic sheeting as needed to avoid spills.
3	Ending Heavy Equipment Operations	3	Leaving equipment in a non-neutral position poses contact hazards causing potential serious injury or death.	H&S	3	4	12	3	All heavy equipment must be placed in a neutral position when not in operation. Dump truck beds must be lowered, buckets must be at ground level, forklift tines must be at ground level, etc. Keys must be removed from all heavy equipment when not in used.

ERM

JHA
Job Hazard Analysis

Project Number:	283566	Project / Client Name:	Subsurface Investigation / MMGL
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way, Portland Oregon
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Oversigh of Use and Using hand tools**

Minimum Required PPE for Entire Task:	☑ Hard Hat ☑ Safety-Toe Shoes ☐ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☑ Safety Glasses ☑ Reflective Vest ☑ Gloves cut resistant ☐ PPE clothing <enter type here (eg, Tyvek, FRC, long sleeves)> <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)	Kevlar or cut-resistant gloves	Equipment / Tools Required:	Miscellaneous hand tools (screwdrivers, hammers, cutting tools, etc.)
Training Required for this Task:		Permits Required for this Task:	Hot Work Permit if working in classified area with combustible atmosphere
Forms Associated with This Task:	Cutting Tools - Operational Control Document		

JHA Developed / Reviewed By:			JHA Review In Field
Name / Job Title:	Name / Job Title:	Name / Job Title:	Field Safety Officer (FSO) to ensure all personnel performing this task have reviewed JHA and agree to follow it. Site-specific changes to this JHA have been made as warranted based on this review. **FSO Signature/Date:**
Bradley Bishop - WD HSE Advisor	Justin Dauphinais / Project Geologist		

Update Tasks and hazards in the field

	Task Steps[1]		Potential Hazards & Consequences[2]	select	Likelihood	Severity	RISK		Controls to Eliminate or Reduce Risks[3]
1a	Gather tools to take to jobsite	1a	An improper tool available at jobsites encourages unsafe behaviors and could lead to injury or property damage	H&S	2	4	8	1a	Ensure tools taken to jobsites are kept in optimal condition (sharp, clean, oiled, etc.) to ensure efficient operation. Tools must only be used for their intended purposes – tools should not be used as pry-bars. Ensure power cords attached to powered-equipment are not damaged. Inspect all power cords for damage prior to use. Remove all damaged tools and cords from service. Any damaged tool or electrical cord must be tagged and taken out of service. If a tool is designed to be handles and used with two hands then two hands must be used. Only use tools for their intended purpose and according to instructions.
2a	Using cutting tools	2a	Major and/or minor claceration bodily injury	H&S	2	2	4	2a	Fixed open-blade knives (such as pocket knives) may not be used on ERM jobsites. Cut-resistant gloves must be worn while using cutting tools or sharp objects. Employees performing significant amounts of cutting tool use should wear high-visibility gloves to encourage awareness of where hands are being placed. Review *Cutting Tools - Operational Control Document* prior to performing cutting tasks.
3a	Using screwdrivers	3a	Puncture and laceration bodily injuries	H&S	2	2	4	3a	Do not hold objects in the palm of your hand and press a screwdriver into it – these objects should be placed on a flat surface. Do not use screwdrivers as hammers or as a cutting tool, or use screwdrivers with broken handles. Use insulated screwdrivers for work on electrical equipment.
4a	Using hammers	4a	Creation of sparks which can cause bodily harm or damage to property or fire	H&S	2	2	4	4a	Use brass hammers and tools in areas where creating sparks would pose ignition hazards.
		4b	Particles may lodge in employee's eyes	H&S	2	2	4	4b	Always use safety glasses when striking any object with a hammer. If hammer-head shows signs of mushrooming, replace it immediately.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
		4c	Loose handles may create a projectile hazard - causing bodily injury or property damage	H&S	2	2	4	4c	Replace any hammer with a loose handle so the hammer-head does not detach and cause injuries.
5a	Using shovels	5a	Using warn or old shovels could lead to failure causing bodily injury or property damage. Improper lifting or lifting too much weight could cause back/muscle strains.	H&S	2	3	6	5a	Inspect shovels before use and make sure they are all in good working order. Use the correct shovel for the job (e.g. snow shovel, spade, etc..) Use proper gloves when using a shovel. Use proper leg and back positioning while using the shovel (e.g. bend knees, do no over lift).

JHA
Job Hazard Analysis

ERM

Project Number:	283866	Project / Client Name:	Southern PEO GW Barrier Wall Install / MMGL Corporation
Project Manager:	Brendan Robinson	Location:	10400 N. Burgard Way, Portland, Oregon
Partner-in-Charge:	Erik Ipsen	Date and Revision Number:	

SPECIFIC TASK:	**Oversight of Excavation and Groundwater Barrier Wall Construction**

Minimum Required PPE for Entire Task:	☑ Hard Hat ☑ Safety-Toe Shoes ☑ Hearing Protection ☐ Goggles ☐ Face Shield ☐ Respirator <enter type and cartridge type> ☐ Other (specify): ☑ Safety Glasses ☑ Reflective Vest ☑ Gloves <enter type here> ☐ PPE clothing Long pants and long sleeve shirts <enter additional PPE here>		
Additional Task-Step Specific PPE: (as indicated below under Controls)	High-visibility safety vest - Vest worn by equipment operators and those working in the area impacted by moving machinery	Equipment / Tools Required:	Excavator, Haul Trucks, ERM Field Vehicle, Fork Lift, Water Trucks
Training Required for this Task:	Heavy Equipment Operation - Operators must be trained and/or have demonstrated experience for each type of heavy equipment they will operate.	Permits Required for this Task:	Hot work permit
Forms Associated with This Task:	Heavy Equipment Inspection form - Form for documenting daily heavy equipment inspections		

JHA Developed / Reviewed By:			JHA Review In Field
Name / Job Title:	Name / Job Title:	Name / Job Title:	Field Safety Officer (FSO) to ensure all personnel performing this task have reviewed JHA and agree to follow it. Site-specific changes to this JHA have been made as warranted based on this review. **FSO Signature/Date:**
Justin Dauphinais / Project Geologist			

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
1	Offsite Preparation	1	Untrained workers operating heavy equipment pose potential life-threatening hazards to employees.	multiple	2	4	8	1	ERM policy and practice is that our employees do not operate heavy equipment except in unusual circumstances. If ERM personnel are to operate heavy equipment, this must be stated in the health and safety plan for the project. Only employees with training and/or demonstrated experience operating heavy equipment may do so. Subcontractor personnel operating heavy equipment must be trained and/or have demonstrated experience operating such equipment. ERM must be in possession of evidence of training and/or experience prior to Subcontractor personnel operating such equipment. All heavy equipment must meet applicable design standards (ANSI, etc.). A copy of the operating manual must be carried on all heavy equipment, including a load-rating chart and any special operating considerations.
2	Heavy Equipment Operation	2a	Injury to operator and those in immediate vicinity by being struck by equipment.	multiple	2	4	8	2a	Before starting operations, operators must ensure no one is working on or near machinery. If equipment is to be operated in close proximity to other workers, a spotter must be working in tandem with the operator. All heavy equipment must be inspected daily to ensure good working order. Critical safety items, such as brakes, backup alarms, horns, etc. must be in working order. Machinery with critical safety items in disrepair may not be used until they are fixed. Operators must operate equipment while wearing seatbelts, if provided, and at reasonable speeds. Mounting/dismounting a moving machine is prohibited. Do not transport personnel or equipment in machinery not designed for this purpose.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
		2b	Working near or under power lines could cause contact with equipment resulting in serious injury or death.	multiple	2	5	10	2b	Overhead obstructions must be assessed before operating machinery. If equipment is to be operated in close proximity to overhead obstructions, a spotter must be working in tandem with the operator. Safe working distances must be specified in the health and safety plan or JHA supplied by the subcontractor. Keep all equipment a minimum of 20 feet away from overhead power lines. Contact local power company for guidance and assitance before beginning any work. Follow ERMs "Guidance on Avoiding Contact with Overhead Utility Lines". 1. When planning work and before setting up machinery on site always LOOK UP and check for overhead utility lines 2. Treat all overhead lines as energized and dangerous. Any contact may be fatal or cause serious injury 3. Lock out or turn off power when possible. 4. Maintain safe distance as electricity can arc or "jump" gaps. 5. Illuminate the work area in poor light conditions.
		2c	Working near or under power lines could cause contact with equipment resulting in serious injury or death.	multiple	2	5	10	2c	Overhead obstructions must be assessed before operating machinery. If equipment is to be operated in close proximity to overhead obstructions, a spotter must be working in tandem with the operator. Safe working distances must be specified in the health and safety plan or JHA supplied by the subcontractor. Keep all equipment a minimum of 20 feet away from overhead power lines. Contact local power company for guidance and assitance before beginning any work. Follow ERMs "Guidance on Avoiding Contact with Overhead Utility Lines". 1. When planning work and before setting up machinery on site always LOOK UP and check for overhead utility lines 2. Treat all overhead lines as energized and dangerous. Any contact may be fatal or cause serious injury 3. Lock out or turn off power when possible. 4. Maintain safe distance as electricity can arc or "jump" gaps. 5. Illuminate the work area in poor light conditions.
		2d	Navigating heavy equipment on sloped terrain could cause rollover resulting in property damage, serious personal injury, or death.	multiple	2	5	10	2d	Pre-map, walk, and review the area and routes. Inspect routes and pathways near sloped areas to find stable lesser sloped passage. Use cones / K-rails to mark sloped areas to avoid or boundaries to stay near and to avoid rollover. Have roll over protection, use seatbelts.
		2e	Tracking contaminated soil onto non-contaminated media or surfaces could result in cross-contamination.	multiple	2	4	8	2e	Follow procedures in ERMs IRA. Do not track material from contaminated excavation areas to clean areas. Use mats to drive on over clean areas is needed. Use rumble strips, gravel, knock off staging area to remove excess dirt from wheels and / or tracks. Use decontamination procedures and / or tire bath. Stop work and talk to ERM staff, PM, Engineers if there are any questions concerning tracking.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
		2f	A leak from hydraulic or fuel lines could cause a release into the environment at the site or surrounding areas.	E	2	4	8	2f	Use funnel when pouring liquid for any operations involving chemicals. Ensure bleed valves are open and lines are clear prior to disconnect and/or use dry couplings. Have the appropritate absorbent material on hand included in the spill kit. (determined by subcontractors HASP) Place container and/or absorbent/plastic sheeting under connection prior to disconnect. Store hazardous materials in dedicated container/area Inspect pressurized lines and all fittings/couplings to ensure integrity/closure. Assess rating and compatibility of materials used vs purpose. Ensure storage compatibility of multiple products. Hazard Communication: For each chemical product used by ERM employees or subcontractors, a MSDS sheet must be obtained and kept on-file. Chemical containers must be labeled in accordance with OSHA regulations. Review MSDS and container label prior to start of task/handling and follow associated requirements. Ensure all employees on the jobsite have been told about the chemical in-use and are protected. Confirm MSDS is relevant when working with legacy material (e.g. historic releases). A chemical inventory list must be prepared and updated as new or different chemicals are procured. Lay down visqueen or plastic sheeting as needed to avoid spills.
3	Barrier Wall Construction	3a	Construction of the barrier wall could cause a release or personal injury from inproper construction and dumping of wall mixing materials.	H&S	2	4	8	3a	Use horn to alert others prior to backing. Stay onsite established distance from operating equipment/extended arm, etc. Make eye contact with equipment operator and receive approval prior to approaching. Ensure spotters and equipment operators maintain eye contact. Establish parking/staging/loading/unloading areas (consider equipment turning circles, swing zones etc.). Chock truck/trailer wheels when not moving. Ensure load is distributed during load/unload to avoid tip/roll-over. Ensure all personnel remain outside of tip-over radius when dumping. Follow barrier wall design drawings specified in ERMs design plan.
		3b	During construction/excavation dust could be created causing cross-contamination. potential arcing of power lines, ingestiion/inhalation of contaminated media. Results could cause illness, serious injury, or death.	H&S	2	5	10	3b	Position body upwind. Keep work area wet to limit dust. Set-up work zone to restrict non-essential access and minimize off-site impacts. Use dust monitors if deamed necessary and stage around work areas and monitor continuously. Limit speeds while driving equipment to keep dust down. Use slow controlled motions while digging and dumping and lower bucket at minimal height when dumping soils to limit dust.
4	Setting up Exclusion Zone for ground disturbance and work areas	4a	Back strain from twisting and carrying supplies.	H&S	2	3	6	4a	Don't twist, bend and keep items close to body; take breaks; bend at knees when lifting items off of ground.
		4b	Cuts and scrapes to hands.		2	3	6	4b	Wear work (puncture/cut resistance) gloves if handling sharp objects, wear nitrile gloves under or over work gloves if soil/water is contaminated.
		4c	Struck by vehicle - bodily injury and death.	H&S	2	4	8	4c	Park vehicles towards oncoming traffic if needed, use spotters when placing delineators / cones, designate person for Stop/Slow sign if working in heavy traffic area.
2	Excavator/backhoe use	5	All workers in the vicinity of the excavator or backhoe are at risk of being struck by the piece of equipment - bodily injury and death.	H&S	2	4	8	5	Excavator/backhoe must be inspected daily before use. Stay out of path and swing radius of equipment and bucket arm. Only approach equipment when visual contact has been made with the operator. Discuss communication signals prior to work starting. Only experienced and certified operators to use equipment.
3	Walking near trench and trenching equipment	6a	Slips, Trips, and Falls resulting in bodily injury.	H&S	2	3	6	6a	Insure walking path is clear prior to using, stay at least 6 feet away from trench sidewall, communicate with other site workers before entering exclusion zones. Delineate and secure all open trenches and excavations at end of shift daily.
		6b	Strike to the head or other body part - bodily injury and death.	H&S	2	4	8	6b	Stay out of swing radius of excavator/backhoe bucket and arm, establish eye contact with operator before approaching.

Task Steps[1]		Potential Hazards & Consequences[2]		select	Likelihood	Severity	RISK	Controls to Eliminate or Reduce Risks[3]	
7	Working in excavations/trenches deeper than 4 feet	7a	Sidewall collapse could cause bodily injury or death.	H&S	2	4	8	7a	Competent Person onsite must determine soil type and appropriate sloping/shoring requirements. Never stand within 6 feet of unprotected edge of excavation vertical wall deeper than 4 feet. Never park vehicles or heavy equipment within two feet of excavation or trench edge.
		7b	Additional hazards of entering trench or excavation that can cause injury or death.	H&S	2	4	8	7b	Any trench deeper than 4 feet is considered a confined space until deemed otherwise by Competent Person, No ERM employees are to enter confined spaces. No one shall enter the trench/excavation until deemed safe to do so by Competent Person. If soil type cannot be easily determined, excavations must be shored or sloped at 1.5h to 1v. All tenches and excavations must have available egress within 25 feet of all entrants. If there is any possibility of hazardous atmosphere within the trench or excavation then real-time air monitoring must take place with results documented periodically.
		7c	Contaminated equipment could result in cross-contamination of media or other surfaces.	E	2	4	8	7c	Follow procedures in ERMs IRA. Do not track material from contaminated excavation areas to clean areas. Use mats to drive on over clean areas is needed. Use rumble strips, gravel, knock off staging area to remove excess dirt from wheels and / or tracks. Use decontamination procedures and / or tire bath. Stop work and talk to ERM staff, PM, Engineers if there are any questions concerning tracking.
8	Suspended loads associated with barrier wall construction		Suspended loads of soil or other equipment needed work barrier wall construction could drop striking equipment or personnel causing property damage or personal injury and/or death.	H&S	2	4	8		Wear all level D PPE (hard hat, steel toe boots, reflective vest, heavy duty mechanics gloves or leather gloves, safety glasses, long sleeve shirts). Do not attempt to catch falling objects. Stay 15 feet away from raised objects. Restrict access with warning tape and/or posted signs. Secure loose objects prior to lifting or moving with straps, sideboards, use of panel cart with high sides. Remove low-hanging objects or identify and/or communicate location to site personnel. Visually inspect equipment before beginning task. Verify latest equipment inspection/tag is current before beginning task. Inspect lifting rigging (chains/slings/cables) to ensure in good condition and do not use if defects, signs of excessive wear are identified. Verify lifting equipment is certified and rated for handling the reach and load limits for required work. Use trained spotter(s) to alert others of hazards. Use tag lines held by trained personnel to guide load and do not wrap lines around body parts. Pre-inspect travel route to ensure clearance. Keep load low to ground to ensure clear visibility when transporting. Move load using low, slow, controlled movements.

MSDS

THIS PAGE INTENTIONALLY LEFT BLANK

MSDS Number: **A2052** * * * * * *Effective Date:* ***08/03/07*** * * * * * *Supercedes:* ***02/16/06***

MSDS *Material Safety Data Sheet*

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker®

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

ALCONOX®

1. Product Identification

Synonyms: Proprietary blend of sodium linear alkylaryl sulfonate, alcohol sulfate, phosphates, and carbonates.
CAS No.: Not applicable.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: A461

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Alconox® proprietary detergent mixture	N/A	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:
May cause irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
No information found.
Fire Extinguishing Media:
Dry chemical, foam, water or carbon dioxide.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. When mixed with water, material foams profusely. Small amounts of residue may be flushed to sewer with plenty of water.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Moisture may cause material to cake. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White powder interspersed with cream colored flakes.
Odor:
No information found.
Solubility:
Moderate (1-10%)
Specific Gravity:
No information found.
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
No information found.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

--------\Cancer Lists\--

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Alconox® proprietary detergent mixture	No	No	None

12. Ecological Information

Environmental Fate:
This product is biodegradable.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Alconox® proprietary detergent mixture	Yes	No	No	No

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Alconox® proprietary detergent mixture	No	No	Yes	No

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Alconox® proprietary detergent mixture	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Alconox® proprietary detergent mixture	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **0** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes.
Keep container closed.
Use with adequate ventilation.
Avoid breathing dust.
Wash thoroughly after handling.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
****
Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MATERIAL SAFETY DATA SHEET

Product Trade Name: **BENTONITE**

Revision Date: 04-Jan-2010

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BENTONITE
Synonyms: None
Chemical Family: Mineral
Application: Weight Additive

Manufacturer/Supplier
Halliburton Energy Services
P.O. Box 1431
Duncan, Oklahoma 73536-0431
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Bentonite	1302-78-9	60 - 100%	Not applicable	Not applicable
Crystalline silica, cristobalite	14464-46-1	0 - 1%	0.025 mg/m^3	$1/2 \times \frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, tridymite	15468-32-3	0 - 1%	0.05 mg/m^3	$1/2 \times \frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, quartz	14808-60-7	< 3	0.025 mg/m^3	$\frac{10\ mg/m^3}{\%SiO2 + 2}$

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview	**CAUTION! - ACUTE HEALTH HAZARD** May cause eye and respiratory irritation. **DANGER! - CHRONIC HEALTH HAZARD** Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease. This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	All standard firefighting media.
Special Exposure Hazards	Not applicable.
Special Protective Equipment for Fire-Fighters	Not applicable.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Health 0*, Flammability 0, Reactivity 0

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.

Procedure for Cleaning / Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.
Respiratory Protection	Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product.
Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Various
Odor:	Odorless
pH:	9.9
Specific Gravity @ 20 C (Water=1):	2.65
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	60
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A). Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).
Skin Contact	May cause mechanical skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Other Information

For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	Not determined
Bio-accumulation	Not Determined

Ecotoxicological Information

Acute Fish Toxicity:	Not determined
Acute Crustaceans Toxicity:	Not determined

Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other Information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Shipping Information

Labels:	None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.

EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory.
WHMIS Hazard Class	D2A Very Toxic Materials Crystalline silica

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.
Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

THIS PAGE INTENTIONALLY LEFT BLANK

MSDS SUMMARY SHEET

Manufacturer:
Name: PHILLIPS PETROLEUM COMPANY
Address 1:
Address 2:
Address 3:
CSZ: BARTLESVILLE **State:** OK **Zipcode:** 74004
Emergency phone: (800) 424-9300
Business phone: 800-762-0942

Product:

Ferndale MSDS#: 1354 **Version # :** 6
Manufacturer MSDS#: 0041
Current? : 2002
Name:

NO. 2 DIESEL FUEL

Synonyms:

CARB **Diesel** TF3
CARB **Diesel**
CARB **Diesel** 10%
Diesel Fuel Oil
EPA Low Sulfur **Diesel** Fuel
EPA Low Sulfur **Diesel** Fuel – Dyed
EPA Off Road High Sulfur **Diesel –** Dyed
Fuel Oil No. 2 – CAS # 68476-30-2
No. 2 **Diesel** Fuel Oil
No. 2 Fuel Oil – Non Hiway – Dyed
No. 2 High Sulfur **Diesel –** Dyed
No. 2 Low Sulfur **Diesel** - Dyed
No. 2 Low Sulfur **Diesel** - Undyed
Crude column 3rd IR
Crude column 3rd side cut
Atmospheric tower 3rd side cut
Ultra Low Sulfur **Diesel** No. 2
Finished **Diesel**
DHT Reactor Feed
Straight Run **Diesel**
Diesel
Middle Distillate

Product/Catalog Numbers:
MSDS Date: 01/01/2002 **(received:** 01/14/2002**)**

NFPA codes:
Health: 0 **Flammability:** 2 **Reactivity:** 0

MATERIAL SAFETY DATA SHEET
No. 2 Diesel Fuel

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: No. 2 Diesel Fuel
Product Code: Multiple
SAP Code:
Synonyms:
1354
CARB Diesel TF3
CARB Diesel
CARB Diesel 10%
Diesel Fuel Oil
EPA Low Sulfur Diesel Fuel
EPA Low Sulfur Diesel Fuel – Dyed
EPA Off Road High Sulfur Diesel – Dyed
Fuel Oil No. 2 – CAS # 68476-30-2
No. 2 Diesel Fuel Oil
No. 2 Fuel Oil – Non Hiway – Dyed
No. 2 High Sulfur Diesel – Dyed
No. 2 Low Sulfur Diesel - Dyed
No. 2 Low Sulfur Diesel – Undyed
No. 2 Ultra Low Sulfur Diesel – Dyed
No. 2 Ultra Low Sulfur Diesel - Undyed

Intended Use: Fuel
Chemical Family:
Responsible Party: Phillip's Petroleum Company
Bartlesville, Oklahoma 74004
For Additional MSDSs: 800-762-0942
Technical Information:

The intended use of this product is indicated above. If any additional use is known, please contact us at the Technical Information number listed.

EMERGENCY OVERVIEW

24 Hour Emergency Telephone Numbers:
Spill, Leak, Fire or Accident
Call CHEMTREC
North America: (800) 424-9300
Others: (703) 527-3887 (collect)

California Poison Control System: 800-356-3120

Health Hazards/Precautionary Measures: Causes severe skin irritation. Aspiration hazard if swallowed. Can enter lungs and cause damage. Use with adequate ventilation. Avoid contact with eyes, skin and clothing. Do not taste or swallow. Wash thoroughly after handling.

Physical Hazards/Precautionary Measures: Flammable liquid and vapor. Keep away from heat, sparks, flames, static electricity or other sources of ignition.

Appearance: Straw-colored to dyed red
Physical Form: Liquid
Odor: Characteristic petroleum

HFPA Hazard Class:
Health: 0 (Least)
Flammability: 2 (Moderate)
Reactivity: 0 (Least)

HMIS Hazard Class
Not Evaluated

2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS COMPONENTS	% VOLUME	Limits	EXPOSURE GUIDELINE Agency	Type
Diesel Fuel No. 2 CAS# 68476-34-6	100	100* mg/m3	ACGIH	TWA-SKIN
Naphthalene CAS# 91-20-3	<1	10ppm	ACGIH	TWA
		15ppm	ACGIH	STEL
		10ppm	OSHA	TWA
		250ppm	NIOSH	IDLH

All components are listed on the TSCA inventory

Tosco Low Sulfur No. 2 Diesel meets the specifications of 40 CFR 60.41 for low sulfur diesel fuel.

Note: State, local or other agencies or advisory groups may have established more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

*Proposed ACGIH (1999)

3. HAZARDS IDENTIFICATION

Potential Health Effects:

Eye: Contact may cause mild eye irritation including stinging, watering, and redness.

Skin: Severe skin irritant. Contact may cause redness, itching, burning, and severe skin damage. Prolonged or repeated contact can worsen irritation by causing drying and cracking of the skin, leading to dermatitis (inflammation). Not actually toxic by skin absorption, but prolonged or repeated skin contact may be harmful (see Section 11).

Inhalation (Breathing): No information available. Studies by other exposure routes suggest a low degree of toxicity by inhalation.

Ingestion (Swallowing): Low degree of toxicity by ingestion. ASPIRATION HAZARD – This material can enter lungs during swallowing or vomiting and cause lung inflammation and damage.

Signs and Symptoms: Effects of overexposure may include irritation of the nose and throat, irritation of the digestive tract, nausea, diarrhea and transient excitation followed by signs of nervous system depression (e.g., headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue).

Cancer: Possible skin cancer hazard (see Sections 11 and 14).

Target Organs: There is limited evidence from animal studies that overexposure may cause injury to the kidney (see Section 11).

Developmental: Inadequate data available for this material.

Pre-Existing Medical Conditions: Conditions aggravated by exposure may include skin disorders and kidney disorders.

4. FIRST AID MEASURES

Eye: If irritation or redness develops, move victim away from exposure and into fresh air. Flush eyes with clean water. If symptoms persist, seek medical attention.

Skin: Immediately remove contaminated shoes, clothing, and constrictive jewelry and flush affected area(s) with large amounts of water. If skin surface is damaged, apply a clean dressing and seek immediate medical attention. If skin surface is not damaged, cleanse affected area(s) thoroughly by washing with mild soap and water. If irritation or redness develops, seek immediate medical attention.

Inhalation (Breathing): If respiratory symptoms develop, move victim away from source of exposure and into fresh air. If symptoms persist, seek medical attention. If victim is not breathing, clear airway and immediately begin artificial respiration. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention.

Ingestion (Swallowing): Aspiration hazard; Do not induce vomiting or give anything by mouth because this material can enter the lungs and cause severe lung damage. If victim is drowsy or unconscious and vomiting, place on the left side with the head down. If possible, do not leave victim unattended and observe closely for adequacy of breathing. Seek medical attention.

5. FIRE FIGHTING MEASURES

Flammable Properties:

Flash Point: >125°F/>52°
OSHA Flammability Class: Combustible liquid
LEL %: 0.3 / UEL %; 10.0
Autoignition Temperature: 500°F/260°C

Unusual Fire & Explosion Hazards: This material is flammable and can be ignited by heat, sparks, flames, or other sources of ignition (e.g., static electricity, pilot lights, or mechanical/electrical equipment, and electronic devices such as cell phones, computers, calculators, and pagers which have not been certified as intrinsically safe). Vapors may travel considerable distances to a source of ignition where they can ignite, flash back, or explode. May create vapor/air explosion hazard indoors, in confined spaces, outdoors, or in sewers. Vapors are heavier than air and can accumulate in low areas. If container is not properly cooled, it can rupture in the heat of a fire.

Extinguishing Media: Dry chemical, carbon dioxide, or foam is recommended. Water spray is recommended to cool or protect exposed materials or structures. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces. Water may be ineffective for extinguishment, unless used under favorable conditions by experienced fire fighters.

Fire Fighting Instructions: For fires beyond the incipient stage, emergency responders in the immediate hazard area should wear bunker gear. When the potential chemical hazard is unknown, in enclosed or confined spaces, or when explicitly required by DOT, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8).

Isolate immediate hazard area, keep unauthorized personnel out. Stop spill/release if it can be done with minimal risk. Move undamaged containers from immediate hazard area if it can be done with minimal risk.

Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done with minimal risk. Avoid spreading burning liquid with water used for cooling purposes.

6. ACCIDENTAL RELEASE MEASURES

Flammable. Keep all sources of ignition and hot metal surfaces away from spill/release. The use of explosion-proof equipment is recommended.

Stay upwind and away from spill/release. Notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done with minimal risk. Wear appropriate protective equipment including respiratory protection as conditions warrant (see Section 8).

Prevent spilled material from entering sewers, storm drains, other unauthorized drainage systems, and natural waterways. Dike far ahead of spill for later recovery or disposal. Use foam on spills to minimize vapors (see Section 5). Spilled material may be absorbed into an appropriate material.

Notify fire authorities and appropriate federal, state, and local agencies. Immediate cleanup of any spill is recommended. If spill of any amount is made into or upon navigable waters, the contiguous zone, or adjoining shorelines, notify the National Response Center (phone number 800-424-8802).

7. HANDLING AND STORAGE

Handling: Open container slowly to relieve any pressure. Bond and ground all equipment when transferring from one vessel to another. Can accumulate static charge by flow or agitation. Can be ignited by static discharged. The use of explosion-proof equipment is recommended and may be required (see appropriate fire codes). Refer to NFPA-704 and/or API RP 2003 for specific bonding/grounding requirements.

Do not enter confined spaces such as tanks or pits without following proper entry procedures such ASTM D-4276 and 29CFR 1910.146. The use of appropriate respiratory protection is advised when concentrations exceed any established exposure limits (see Sections 2 and 8).

Do not wear contaminated clothing or shoes. Keep contaminated clothing away from sources of ignition such as sparks or open flames. Use good personal hygiene practices.

High pressure injection of hydrocarbon fuels, hydraulic oils or greases under the skin may have serious consequences even though no symptoms or injury may be apparent. This can happen accidentally when using high pressure equipment such as high pressure grease guns, fuel injection apparatus or from pinhole leaks in tubing or high pressure hydraulic oil equipment.

“Empty” containers retain residue and may be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury or death. “Empty” drums should be completely drained, properly bunged, and promptly shipped to the supplier or a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

Before working on or in tanks which contain or have contained this material, refer to OSHA regulations, ANSIZ49.1 and other references pertaining to cleaning, repairing, welding, or other contemplated operations.

Storage: Keep container(s) tightly closed. Use and store this material in cool, dry, well-ventilated areas away from heat, direct sunlight, hot metal surfaces, and all sources of ignition. Post area “No Smoking or Open Flame.” Store only in approved containers. Keep away from incompatible material (see Section 10). Protect container(s) against physical damage. Outdoor or detached storage is preferred. Indoor storage should meet OSHA standards and appropriate fire codes.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering controls: If current ventilation practices are not adequate to maintain airborne concentration below the established exposure limits (see Section 2), additional ventilation or exhaust systems may be required. Where explosive mixtures may be present, electrical systems safe for such locations must be used (see appropriate electrical codes).

Personal Protective Equipment (PPE):

Respiratory: A NIOSH certified air purifying respirator with an organic vapor cartridge maybe used under conditions where airborne concentrations are expected to exceed exposure limits (see Section 2).

Protection provided by air purifying respirators is limited (see manufacturer's respirator selection guide). Use a positive pressure air supplied respirator if there is a potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection.

A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrants a respirator's use.

Skin: The use of gloves impervious to the specific material handled is advised to prevent skin contact, possible irritation and skin damage (see glove manufacturer literature for information on permeability). Depending on conditions of use, apron and/or arm covers may be necessary.

Eyes/Face: Approved eye protection to safeguard against potential eye contact, irritation, or injury is recommended. Depending on conditions of use, a face shield may be necessary.

Other Protective Equipment: Eye wash and quick-drench shower facilities should be available in the work area. Thoroughly clean shoes and wash contaminated clothing before reuse. It is recommended that impervious clothing be worn when skin contact is possible.

9. PHYSICAL AND CHEMICAL PROPERTIES

Note: Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1atm).

Appearance: Straw-colored to dyed red
Physical State: Liquid
Odor: Characteristic petroleum
pH: unavailable
Vapor Pressure (mm Hg): 0.40
Vapor Densisty (air=1):>3
Boiling Point/Range: 320-700°F /160-371°C
Freezing/Melting Point: No Data
Solubility in Water: Negligible
Specific Gravity: 0.81-0.88 @ 60°F
Percent Volatile: Negligible
Evaporation Rate (nBuAc=1): <1
Viscosity: 32.6-40.0 SUS @ 100°F
Bulk Density: 7.08 lbs/gal
Flash Point: >125°F / >52°C
Flammable/Expolsive Limits (%): LEL: 0.3 / UEL: 10.0

10. STABILITY AND REACTIVITY

Stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Flammable liquid and vapor. Vapor can cause flash fire.

Conditions To Avoid: Avoid all possible sources of ignition (see Sections 5 and 7).

Materials to Avoid (Incompatible Materials): Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite, calcium hypochlorite, etc.

Hazardous Decomposition Products: The use of hydrocarbon fuels in an area without adequate ventilation may result in hazardous levels of combustion products (e.g., oxides of carbon, sulfur and nitrogen, benzene and other hydrocarbons) and/or dangerously low oxygen levels. ACGIH has included a TLV of 0.05 mg/m3 TWA for diesel exhaust particulate on its 1999 Notice of Intended Changes. See Section 11 for additional information on hazards of engine exhaust.

Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Diesel Fuel No. 2 (CAS# 68476-34-6)

Carcinogenicity: Chronic dermal application of certain middle distillate streams contained in diesel fuel No. 2 resulted in an increased incidence of skin tumors in mice. This material has not been identified as carcinogen by NTP, IARC, or OSHA. Diesel exhaust is a probable cancer hazard based on tests with laboratory animals.

Target Organ(s): Limited evidence of renal impairment has been noted from a few case reports involving excessive exposure to diesel fuel No. 2.

Naphthalene (CAS# 91-20-3)

Carcinogenicity: Naphthalene has been evaluated in two year inhalation studies in both rats and mice. The National Toxicology Program (NTP) concluded that there is clear evidence of carcinogenicity in male and female rats based on increased incidences of respiratory epithelial adenomas and olfactory epithelial neuroblastomas of the nose. NTP found some evidence of carcinogenicity in female mice (alveolar adenomas) and no evidence of carcinogenicity in male mice. Naphthalene has not been identified as a carcinogen by IARC or OSHA.

12. ECOLOGICAL INFORMATION

Not evaluated at this time

13. DISPOSAL CONSIDERATIONS

This material, if discarded as produced, would be a RCRA "characteristic" hazardous waste due to the characteristic(s) of ignitability (D001) and benzene (D018). If the material is spilled to soil or water, characteristic testing of the contaminated materials is recommended. Further, this material, once it becomes a waste, is subject to the land disposal restrictions in 40 CFR 268.40 and may require treatment prior to disposal to meet specific standards. Consult state and local regulations to determine whether they are more stringent then the federal requirements.

Container contents should be completely used and containers should be emptied prior to discard. Container ?insate? could be considered a RCRA hazardous waste and must be disposed of with care and in compliance with federal, state and local regulations. Large empty containers, such as drums, should be returned to the distributor or to a drum reconditioner. To assure proper disposal of smaller containers, consult with state and local regulations and disposal authorities.

14. TRANSPORT INFORMATION

DOT Shipping Description: Diesel Fuel, NA1983
Non-Bulk Package Marking: Diesel Fuel, 3, NA 1993, III

15. REGULATORY INFORMATION

EPA SARA 311/312 (Title III Hazard Categories):

Acute Health:	Yes
Chronic Health:	Yes
Fire Hazard:	Yes
Pressure Hazard:	No
Reactive Hazard:	No

SARA 313 and 40 CFR 372:
This material contains the following chemicals subject to the reporting requirements of SARA 313 and 40 CFR 372:

Component	CAS Number	Weight %
-- None known --		

California Proposition 65:
Warning: This material contains the following chemicals which are known to the state of California to cause cancer, birth defects or other reproductive harm, and are subject to the requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5):

Component	Effect
Benzene	Cancer, Developmental and Reproductive Toxicant
Toluene	Developmental Toxicant

Diesel engine exhaust, while not a component of this material, is on the Proposition 65 list of chemicals known to the State of California to cause cancer.

Carcinogen Identification:
This material has not been identified as a carcinogen by NTP, IARC, or OSHA. See Section 11 for carcinogenicity information of individual components, if any. Diesel exhaust is a probable cancer hazard based on tests in laboratory animals. It has been identified as carcinogen by IARC.

EPA (CERCLA Reportable Quantity: None

16. OTHER INFORMATION

Issue Date: 01/01/02
Previous Issue Date: 05/15/01
Product Code: Multiple
Revised Sections: None
Previous Product Code: Multiple
MSDS Number: 0041

Disclaimer of Expressed and Implied Warranties:

The information presented in this Material Data Safety Sheet is based on data believed to be accurate as of the date this Material Data Sheet was prepared. HOWEVER, NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY IS EXPRESSED OR IS TO BE IMPLIED REGARDING THE ACCURACY OR COMPLETENESS OF THE INFORMATION PROVIDED ABOVE, THE RESULTS TO BE OBTAINED FROM THE USE OF THIS INFORMATION OR THE PRODUCT, THE SAFETY OF THE PRODUCT, OR THE HAZARDS RELATED TO ITS USE. No responsibility is assumed for any damage or injury resulting from abnormal use or from any failure to adhere to recommended practices. The information provided above, and the product, are furnished on the condition that the person receiving them shall make their own determination as to the suitability of the product for their particular purpose and on the condition that they assume the risk of their use. In addition, no authorization is given nor implied to practice any patented invention without a license.

UltraLow Sulfur Diesel Product Specification

Ferndale Product Code:34380xx (5) Product Code: ULSD2

(COMETS)

Specification	Unit	Limit	Test Procedure	Typical
Appearance				
Water & Sediment	Vol %	0.05 Max	D 2709	
Color	Number	3.0 Max	D 1500	
Haze Rating	Rating	2 Max	D 4176	
Composition				
Carbon Residue (Ramsbottom)	Wt %	0.35 Max	D 524, D 189	
Volatility				
90% Recovered	Deg; F	540 Min	D 86	
	Deg; F	640 Min	D 86	
Flash Point	Deg; F	125 Min (1)	D 93	130 F
Gravity	API	30 Min	D 287, D4052	
Fluidity				
Pour Point	Deg; F	See Season Table (6)	D 97	
Cloud Point	Deg; F	See Season Table (6)	D 2500	10 F
Viscosity @ 104F	cSt	1.9 Min	D 445	
	cSt	4.1 Max	D 445	
Lubricity, SLBOCLE	grams	3100 Min	D 6078	3300gm
Lubricity, HFRR	mm	.45	D 6079	
Combustion				
Cetane Index or Cetane Number (3,4)	Number	40.0 Min	D 976, D613	47.0
Corrosion				
Copper Strip, 3hr @ 50 deg C	Number	3 Max (2)	D 130	
Aromatics (4)	Vol %	35 Max	D 1319	25 %
Contaminants				
Total Sulfur	PPM	30 Max	D 2622, D4294	15-20ppm
Water & Sediment	Vol %	0.05 Max	D 1796	
Ash	Wt %	0.01 Max	D 482	
Additives				
Cetane Improver	Lb/MBbl	675 Max		
Dye		Undyed		

1. Minimum release specification is 125 deg. F. The refinery should target 135 deg. F.
2. Test result reported as a number and letter (e.g. 1a). Any letter is allowable as long as the number meets the spec shown.
3. Either specification must be met.
4. Either cetane index minimum or aromatics maximum must be met.
5. Winter cloud and pour specifications may be relaxed to the summer specifications by agreement with the customer.
6. Season Table

Month	Product Code	Pour Point	Cloud Point
Jan, Feb, Nov, Dec	WI	0 max (5)	14 max (5)
Mar - Oct	SU	15 max	24 max

Material Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

CHEVRON REGULAR UNLEADED GASOLINE

Product Number(s): CPS201000 [See Section 16 for Additional Product Numbers]
Synonyms: Calco Regular Unleaded Gasoline

Company Identification
Chevron Products Company
Marketing, MSDS Coordinator
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887
Health Emergency
ChevronTexaco Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
Technical Information: (510) 242-5357

SPECIAL NOTES: This MSDS applies to: Federal Reformulated Gasoline, California Reformulated Gasoline, Wintertime Oxygenated Gasoline, Low RVP Gasoline and Conventional Gasoline.

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Gasoline	86290-81-5	100 %volume
Benzene	71-43-2	0.1 - 4.9 %volume
Ethyl benzene	100-41-4	0.1 - 3 %volume
Naphthalene	91-20-3	0.1 - 2 %volume
Ethanol	64-17-5	0 - 10 %volume
Methyl tert-butyl ether (MTBE)	1634-04-4	0 - 15 %volume
Tertiary amyl methyl ether (TAME)	994-05-8	0 - 17 %volume
Ethyl tert-butyl ether (ETBE)	637-92-3	0 - 18 %volume

Motor gasoline is considered a mixture by EPA under the Toxic Substances Control Act (TSCA). The refinery streams used to blend motor gasoline are all on the TSCA Chemical Substances Inventory. The appropriate CAS number for refinery blended motor gasoline is 86290-81-5. The product specifications of motor gasoline sold in your area will depend on applicable Federal and State regulations.

SECTION 3 HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

- EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE
- HARMFUL OR FATAL IF SWALLOWED - MAY CAUSE LUNG DAMAGE IF SWALLOWED
- VAPOR HARMFUL
- CAUSES SKIN IRRITATION
- CAUSES EYE IRRITATION
- LONG-TERM EXPOSURE TO VAPOR HAS CAUSED CANCER IN LABORATORY ANIMALS
- KEEP OUT OF REACH OF CHILDREN
- TOXIC TO AQUATIC ORGANISMS

****

IMMEDIATE HEALTH EFFECTS
Eye: Contact with the eyes causes irritation. Symptoms may include pain, tearing, reddening, swelling and impaired vision.
Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response. Not expected to be harmful to internal organs if absorbed through the skin.
Ingestion: Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death.
Inhalation: The vapor or fumes from this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Breathing this material at concentrations above the recommended exposure limits may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Reproduction and Birth Defects: This material is not expected to cause birth defects or other harm to the developing fetus based on animal data.
Cancer: Prolonged or repeated exposure to this material may cause cancer. Gasoline has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Contains benzene, which has been classified as a carcinogen by the National Toxicology Program (NTP) and a Group 1 carcinogen (carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains ethylbenzene which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Whole gasoline exhaust has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Risk depends on duration and level of exposure. See Section 11 for additional information.

SECTION 4 FIRST AID MEASURES

Eye: Flush eyes with water immediately while holding the eyelids open. Remove contact lenses, if worn, after initial flushing, and continue flushing for at least 15 minutes. Get medical attention if irritation persists.
Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue.
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

See Section 7 for proper handling and storage.

FIRE CLASSIFICATION:
OSHA Classification (29 CFR 1910.1200): Flammable liquid.

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

FLAMMABLE PROPERTIES:
Flashpoint: (Tagliabue Closed Cup) < -45 °C (< -49 °F)
Autoignition: > 280 °C (> 536 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 1.4 Upper: 7.6

EXTINGUISHING MEDIA: Dry Chemical, CO2, AFFF Foam or alcohol resistant foam if >15% volume polar solvents (oxygenates).

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: Use water spray to cool fire-exposed containers and to protect personnel. For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required. This material is covered by EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Petroleum Exclusion. Therefore, releases to the environment may not be reportable under CERCLA.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL. This product presents an extreme fire hazard. Liquid very quickly evaporates, even at low temperatures, and forms vapor (fumes) which can catch fire and burn with explosive violence. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Never siphon gasoline by mouth.
Use only as a motor fuel. Do not use for cleaning, pressure appliance fuel, or any other such use. Do not store in open or unlabeled containers. Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Wash thoroughly after handling. Keep out of the reach of children.
Unusual Handling Hazards: WARNING! Do not use as portable heater or appliance fuel. Toxic fumes may accumulate and cause death.
General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating an accumulation of electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003, 'Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents'. Improper filling of portable gasoline containers creates danger of fire. Only dispense gasoline into approved and properly labeled gasoline containers. Always place portable containers on the ground. Be sure pump nozzle is in contact with the container while filling. Do not use a nozzle's lock-open device. Do not fill portable containers that are inside a vehicle or truck/trailer bed.

General Storage Information: DO NOT USE OR STORE near heat, sparks or open flames. USE AND STORE ONLY IN WELL

VENTILATED AREA. Keep container closed when not in use.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:
Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:
Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT
Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.
Skin Protection: No special protective clothing is normally required. Where splashing is possible, select protective clothing depending on operations conducted, physical requirements and other substances in the workplace. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.
Respiratory Protection: Determine if airborne concentrations are below the recommended exposure limits. If not, wear an approved respirator that provides adequate protection from measured concentrations of this material, such as: Air-Purifying Respirator for Organic Vapors.
When used as a fuel, this material can produce carbon monoxide in the exhaust.   Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.
Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.

Occupational Exposure Limits:

Component	Limit	TWA	STEL	Ceiling	Notation
Benzene	ACGIH_TLV	.5 ppm	2.5 ppm		Skin A1
Benzene	OSHA_PEL	1 ppm	5 ppm		
Benzene	OSHA_Z2	10 ppm		25 ppm	
Ethanol	ACGIH_TLV	1000 ppm			A4
Ethanol	OSHA_PEL	1000 ppm			
Ethyl benzene	ACGIH_TLV	100 ppm	125 ppm		A3
Ethyl benzene	OSHA_PEL	100 ppm	125 ppm		
Ethyl tert-butyl ether (ETBE)	ACGIH_TLV	5 ppm			
Gasoline	ACGIH_TLV	300 ppm	500 ppm		A3
Gasoline	OSHA_PEL	300 ppm	500 ppm		

Methyl tert-butyl ether (MTBE)	ACGIH_TLV	50 ppm			A3
Naphthalene	ACGIH_TLV	10 ppm	15 ppm		Skin A4
Naphthalene	OSHA_PEL	10 ppm	15 ppm		
Tertiary amyl methyl ether (TAME)	CHEVRON		50 ppm		

Refer to the OSHA Benzene Standard (29 CFR 1910.1028) and Table Z-2 for detailed training, exposure monitoring, respiratory protection and medical surveillance requirements before using this product.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Colorless to yellow
Physical State: Liquid
Odor: Petroleum odor
pH: NA
Vapor Pressure: 5 psi - 15 psi (Typical) @ 37.8°C (100°F)
Vapor Density (Air = 1): 3 - 4 (Typical)
Boiling Point: 37.8°C (100°F) - 204.4°C (400°F) (Typical)
Solubility: Insoluble in water; miscible with most organic solvents.
Freezing Point: NA
Melting Point: NA
Specific Gravity: 0.7 g/ml - 0.8 g/ml @ 15.6°C (60.1°F)
Viscosity: <1 SUS @ 37.8°C (100°F)

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: May react with strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS
Eye Irritation: The Draize eye irritation mean score in rabbits for a 24-hour exposure was: 0/110.
Skin Irritation: For a 4-hour exposure, the Primary Irritation Index (PII) in rabbits is: 4.8/8.0.
Skin Sensitization: This material did not cause sensitization reactions in a Modified Buehler guinea pig test.
Acute Dermal Toxicity: 24 hour(s) LD50: >3.75g/kg (rabbit).
Acute Oral Toxicity: LD50: >5 ml/kg (rat)
Acute Inhalation Toxicity: 4 hour(s) LD50: >2000ppm (rat).

ADDITIONAL TOXICOLOGY INFORMATION:
Gasolines are highly volatile and can produce significant concentrations of vapor at ambient temperatures. Gasoline vapor is heavier than air and at high concentrations may accumulate in confined spaces to present both safety and heath hazards. When vapor exposures are low, or short duration and infrequent, such as during refuelling and tanker loading/unloading, neither total hydrocarbon nor components such as benzene are likely to result in any adverse health effects. In situations such as accidents or spills where exposure to gasoline vapor is potentially high, attention should be paid to potential toxic effects of specific components. Information about specific components in gasoline can be found in Sections 2, 8 and 15 of this MSDS. More detailed information on the health hazard of specific gasoline components can be obtained calling the Chevron Emergency Information Center (see Section 1 for phone numbers).

NEUROTOXICITY: Pathological misuse of solvents and gasoline, involving repeated and prolonged exposure to high concentrations of vapor is a significant exposure on which there are many reports in the medical literature. As with other solvents, persistent abuse involving repeated and prolonged exposures to high concentrations of vapor has been reported to result in central nervous system damage and eventually, death. In a study in which ten human volunteers were exposed for 30 minutes to approximately 200, 500 or 1000 ppm concentrations of gasoline vapor, irritation of the eyes was the only significant effect observed, based on both subjective and objective assessments. In an inhalation study, groups of 6 Fischer rats (3 male. 3 female) were exposed to 2056 ppm of wholy vaporized unleaded gasoline for 6 hours perday, 5 day per week for up to 18 months. Histopathology of the peripheral nervous system and spinal cord revealed no distal axonal neuropthy of the type associated with exposure to n-hexane even though gasoline contained 1.9% n-hexane. The authors concluded that gasoline treatment may have amplified the incidence and prominence of some naturally occurring age-related (subclinical) in the nervous system. BIRTH DEFECTS AND REPRODUCTIVE TOXICITY: An inhalation study with rats exposed to 0, 400 and 1600 ppm of wholly vaporized unleaded gasoline, 6 hours per day on day 6 through 16 of gestation, showed no teratogenic effects nor indication of toxicity to either the mother or the fetus. Another inhalation study in rats exposed to 3000, 6000, or 9000 ppm of gasoline vapor, 6 hours per day on day 6 through 20 of gestation, also showed no teratogenic effects nor indications of toxicity to either the mother or the fetus.

CHRONIC TOXICITY/CANCER: Wholly vaporized unleaded gasoline was used in a 3 month inhalation study. Groups of 40 rats (20 males, 20 female) and 8 squirrel monkeys (4 male, 4 female) were exposed 6 hours per day and 5 days per week for 13 weeks to 384 or 1552 ppm gasoline. One group of each species served as unexposed controls. The initial conclusion of this study was that inhalation of gasoline at airborne concentrations of up to 1522 ppm caused no toxicity in rats or monkeys. However, further histopathological examination of male rat kidneys on the highest dose group revealed an increased incidence and severity of regenerative epithelium and dilated tubules containing proteinaceous deposits. Lifetime inhalation of wholly vaporized unleaded gasoline at 2056 ppm has caused increased liver tumors in female mice. The mechanism of this response is still being investigated but it is thought to be an epigenetic process unique to the female mouse.

This exposure also caused kidney damage and eventually kidney cancer in male rats. No other animal model studied has shown these adverse kidney effects and there is no physiological reason to believe that they would occur in man. EPA has concluded that mechanism by which wholly vaporzied unleaded gasoline causes kidney damage is unque to the male rat. The effects in that species (kidney damage and cancer) should not be used in human risk assesment. In their 1988 review of carcinogenic risk from gasoline, The International Agency for Research on Cancer (IARC) noted that, because published epidemiology studies did not include any exposure data, only occupations where gasoline exposure may have ocurred were reviewed. These included gasoline service station attendants and automobile mechanics. IARC also noted that there was no opportunity to separate effects of combustion products from those of gasoline itself. Although IARC allocated gasoline a final overall classification of Group 2B, i.e. possibly carcinogenic to humans, this was based on limited evidence in experimental animals plus supporting evidence including the presence in gasoline of benzene and 1, 3-butadiene. The actual evidence for carcinogenicity in humans was considered inadequate.

MUTAGENICITY: Gasoline was not mutagenic, with or without activation, in the Ames assay (Salmonella typhimurium), Saccharamyces cerevisesae, or mouse lymphoma assays. In addition, point mutations were not induced in human lymphocytes. Gasoline was not mutagenic when tested in the mouse dominant lethal assay. Administration of gasoline to rats did not cause chomosomal aberrations in their bone marrow cells. EPIDEMIOLOGY: To explore the health effects of workers potentially exposed to gasoline vapors in the marketing and distribution sectors of the petroleum industry, the American Petroleum Institute sponsored a cohort mortality study (Publication 4555), a nested case-control study (Publication 4551), and an exposure assessment study (Publication 4552). Histories of exposure to gasoline were reconstructed for cohort of more than 18,000 employees from four companies for the time period between 1946 and 1985. The results of the cohort mortality study indicated that there was no increased mortality from either kidney cancer or leukemia among marketing and marine distribution employees who were exposed to gasoline in the petroleum industry, when compared to the general population. More importantly, based on internal comparisons, there was no association between mortality from kidney cancer or leukemia and various indices of gasoline exposure. In particular, neither duration of employment, duration of exposure, age at first exposure, year of first exposure, job category, cumulative exposure, frequency of peak exposure, nor average intensity of exposure had any effect on kidney cancer or leukemia mortality. The results of the nested case-control study confirmed the findings of the original cohort study. That is, exposure to gasoline at the levels experienced by this cohort of distribution workers is not a significant risk factor for leukemia (all cell types), acute myeloid leukemia, kidney cancer or multiple myeloma.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY
The 96 hour(s) LC50 for rainbow trout (Oncorhynchus mykiss) is 2.7 mg/l.
The 48 hour(s) LC50 for water flea (Daphnia magna) is 3.0 mg/l.
The 96 hour(s) LC50 for sheepshead minnow (Cyprinodon variegatus) is 8.3 mg/l.
The 96 hour(s) LC50 for mysid shrimp (Mysidopsis bahia) is 1.8 mg/l.
This material is expected to be toxic to aquatic organisms. Gasoline studies have been conducted in the laboratory under a variety of test conditions with a range of fish and invertebrate species. An even more extensive database is available on the aquatic toxicity of individual aromatic constituents. The majority of published studies do not identify the type of gasoline evaluated, or even provide distinguishing characteristics such as aromatic content or presence of lead alkyls. As a result, comparison of results among studies using open and closed vessels, different ages and species of test animals and different

gasoline types, is difficult.

The bulk of the available literature on gasoline relates to the environmental impact of monoaromatic (BTEX) and diaromatic (naphthalene, methylnaphthalenes) constituents. In general, non-oxygenated gasoline exhibits some short-term toxicity to freshwater and marine organisms, especially under closed vessel or flow-through exposure conditions in the laboratory. The components which are the most prominent in the water soluble fraction and cause aquatic toxicity, are also highly volatile and can be readily biodegraded by microorganisms.

ENVIRONMENTAL FATE

This material is expected to be readily biodegradable. Following spillage, the more volatile components of gasoline will be rapidly lost, with concurrent dissolution of these and other constituents into the water. Factors such as local environmental conditions (temperature, wind, mixing or wave action, soil type, etc), photo-oxidation, biodegradation and adsorption onto suspended sediments, can contribute to the weathering of spilled gasoline.

The aqueous solubility of non-oxygenated unleaded gasoline, based on analysis of benzene, toluene, ethylbenzene+xylenes and naphthalene, is reported to be 112 mg/l. Solubility data on individual gasoline constituents also available.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by US EPA under RCRA (40 CFR 261) or other State and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination. If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Name: GASOLINE
DOT Hazard Class: 3 (Flammable Liquid)
DOT Identification Number: UN1203
DOT Packing Group: II

SECTION 15 REGULATORY INFORMATION

SARA 311/312 CATEGORIES:

1. Immediate (Acute) Health Effects: YES
2. Delayed (Chronic) Health Effects: YES
3. Fire Hazard: YES
4. Sudden Release of Pressure Hazard: NO
5. Reactivity Hazard: NO

REGULATORY LISTS SEARCHED:

4_I1=IARC Group 1	15=SARA Section 313
4_I2A=IARC Group 2A	16=CA Proposition 65
4_I2B=IARC Group 2B	17=MA RTK
05=NTP Carcinogen	18=NJ RTK
06=OSHA Carcinogen	19=DOT Marine Pollutant

09=TSCA 12(b) 20=PA RTK

The following components of this material are found on the regulatory lists indicated.

Benzene	15, 16, 17, 18, 20, 4_I1, 5, 6
Ethanol	17, 18, 20
Ethyl benzene	15, 17, 18, 20, 4_I2B
Gasoline	17, 18, 20
Methyl tert-butyl ether (MTBE)	15, 17, 18, 20, 9
Naphthalene	15, 16, 17, 18, 20, 4_I2B
Tertiary amyl methyl ether (TAME)	9

CERCLA REPORTABLE QUANTITIES(RQ)/SARA 302 THRESHOLD PLANNING QUANTITIES(TPQ):

Component	Component RQ	Component TPQ	Product RQ
Benzene	10 lbs	None	186 lbs
Ethanol	100 lbs	None	1961 lbs
Ethyl benzene	1000 lbs	None	34964 lbs
Methyl tert-butyl ether (MTBE)	1000 lbs	None	7513 lbs
Naphthalene	100 lbs	None	4000 lbs

CHEMICAL INVENTORIES:
CANADA: All the components of this material are on the Canadian DSL or have been notified under the New Substance Notification Regulations, but have not yet been published in the Canada Gazette.
UNITED STATES: All of the components of this material are on the Toxic Substances Control Act (TSCA) Chemical Inventory.

WHMIS CLASSIFICATION:
Class B, Division 2: Flammable Liquids
Class D, Division 2, Subdivision A: Very Toxic Material -
Carcinogenicity
Class D, Division 2, Subdivision B: Toxic Material -
Skin or Eye Irritation

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

Additional Product Number(s): CPS201023, CPS201054, CPS201055, CPS201075, CPS201090, CPS201105, CPS201106, CPS201120, CPS201121, CPS201122, CPS201126, CPS201128, CPS201131, CPS201136, CPS201141, CPS201142, CPS201148, CPS201153, CPS201158, CPS201161, CPS201162, CPS201168, CPS201181, CPS201185, CPS201186, CPS201188, CPS201216, CPS201217, CPS201218, CPS201236, CPS201237, CPS201238, CPS201266, CPS201267, CPS201268, CPS201277, CPS201278, CPS201279, CPS201286, CPS201287, CPS201289, CPS201296, CPS201297, CPS201298, CPS201849, CPS201850, CPS201855, CPS201856, CPS201857, CPS204000, CPS204001, CPS204002, CPS204003, CPS204010, CPS204011, CPS204022, CPS204023, CPS204046, CPS204047, CPS204070, CPS204071, CPS204088, CPS204089, CPS204104, CPS204105, CPS204116, CPS204117, CPS204140, CPS204141, CPS204164, CPS204165, CPS204188, CPS204189, CPS204200, CPS204201, CPS204212, CPS204213, CPS204224, CPS204225, CPS204248, CPS204249, CPS204272, CPS204273, CPS204290, CPS204291, CPS204322, CPS204323, CPS204324, CPS204350, CPS204352, CPS204354, CPS204356, CPS204358, CPS204359, CPS204364, CPS204365, CPS204370, CPS204371, CPS204376, CPS204377, CPS204382, CPS204383, CPS204388, CPS204389, CPS204394, CPS204395, CPS204400, CPS204401, CPS204406, CPS204407, CPS204412, CPS204413, CPS204418, CPS204419, CPS204424, CPS204425, CPS204430, CPS204431, CPS204436, CPS204437, CPS204442, CPS204446, CPS204450, CPS204454, CPS204458, CPS204462, CPS204466, CPS204467, CPS204484, CPS204485, CPS204502, CPS204503, CPS204520, CPS204521, CPS204538, CPS204539, CPS204556, CPS204557, CPS204574, CPS204575, CPS204592, CPS204593, CPS204610, CPS204611, CPS204628, CPS204629, CPS204646, CPS204647, CPS204664, CPS204665, CPS204682, CPS204690, CPS204691, CPS204696, CPS204697, CPS204702, CPS204703, CPS204708, CPS204709, CPS204721, CPS204722, CPS204727, CPS204728, CPS241765

REVISION STATEMENT: This revision updates the following sections of this Material Safety Data Sheet: Section 1 (Product Codes). This Material Safety Data Sheet has been prepared using the ProSteward MSDS system.

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV	-	Threshold Limit Value	TWA	-	Time Weighted Average
STEL	-	Short-term Exposure Limit	PEL	-	Permissible Exposure Limit
			CAS	-	Chemical Abstract Service Number
NDA	-	No Data Available	NA	-	Not Applicable
<=	-	Less Than or Equal To	>=	-	Greater Than or Equal To

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the ANSI MSDS Standard (Z400.1) by the ChevronTexaco Energy Research & Technology Company, 100 Chevron Way, Richmond, California 94802.

SCOTT SPECIALTY GASES -- ISOBUTYLENE IN AIR, (SEE SUPPL.) -- 6665-01-449-8454

===================== Product Identification =====================

Product ID:ISOBUTYLENE IN AIR, (SEE SUPPL.)
MSDS Date:11/20/1997
FSC:6665
NIIN:01-449-8454
Status Code:A
Kit Part:Y
MSDS Number: CLFCR
=== Responsible Party ===
Company Name:SCOTT SPECIALTY GASES
Address:2330 HAMILTON BLVD
City:SOUTH PLAINFIELD
State:NJ
ZIP:07080
Country:US
Info Phone Num:908-754-7700
Emergency Phone Num:908-754-7700
Resp. Party Other MSDS Num.:M-704/E-1
CAGE:54262
=== Contractor Identification ===
Company Name:PHOTOVAC INTL INC/DBA PHOTOVAC MONITORING INSTRUMENTS
Address:UNK
Box:UNK
City:DEER PARK
State:NY
ZIP:11729
Country:US
Phone:000-000-0000
CAGE:70123
Company Name:PINE ENVIRONMENTAL SERVICES INC
Address:379 PRINCETON-HIGHTSTOWN RD
Box:City:CRANBURY
State:NJ
ZIP:08512
Country:US
Phone:609-371-9663
Contract Num:SP0200-99-M-T071
CAGE:1JSC4
Company Name:SCOTT SPECIALTY GASES
Address:2330 HAMILTON BLVD
Box:City:SOUTH PLAINFIELD
State:NJ
ZIP:07080
Country:US
Phone:908-754-7700
CAGE:54262

============= Composition/Information on Ingredients =============

Ingred Name:ISOBUTYLENE
CAS:115-11-7
RTECS #:UD0890000
Fraction by Wt: 1-1500% PPM

Ingred Name:AIR
CAS:132259-10-0

Fraction by Wt: BALANCE

==================== Hazards Identification ====================

Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE EFFECTS: NONE. CHRONIC EFFECTS: NONE KNOWN.
Explanation of Carcinogenicity:CARCINOGENICITY (U.S. ONLY): NTP - NO; IARC MONOGRAPHS - NO; OSHA REGULATED - NO.
Effects of Overexposure:NONE.
Medical Cond Aggravated by Exposure:NONE KNOWN.

====================== First Aid Measures ======================

First Aid:IN EVENT OF EXPOSURE, CONSULT A PHYSICIAN. INHALATION: IMMEDIATELY REMOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. EYE CONTAC T: NONE. SKIN CONTACT: NONE. INGESTION: NONE.

==================== Fire Fighting Measures ====================

Flash Point:NONFLAMMABLE
Extinguishing Media:USE WHAT IS APPROPRIATE FOR SURROUNDING FIRE.
Fire Fighting Procedures:WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECIVE CLOTHING. KEEP FIRE EXPOSED CYLINDERS COOL WITH WATER SPRAY. IF POSSIBLE, STOP THE PRODUCT FLOW.
Unusual Fire/Explosion Hazard:CYLINDER RUPTURE MAY OCCUR UNDER FIRE CONDITIONS. COMPRESSED AIR AT HIGH PRESSURE WILL ACCELERATE THE COMBUSTION OF FLAMMABLE MATERIALS.

================== Accidental Release Measures ==================

Spill Release Procedures:EVACUATE AND VENTILATE AREA. REMOVE LEAKING CYLINDER TO EXHAUST HOOD OR SAFE OUTDOOR AREA. SHUT OFF SOURCE IF POSSIBLE AND REMOVE SOURCE OF HEAT.

====================== Handling and Storage ======================

Handling and Storage Precautions:HANDLING: SECURE CYLINDER WHEN USING TO PROTECT FROM FALLING. USE SUITABLE HAND TRUCK TO MOVE CYLINDERS. STORAGE: STORE IN WELL VENTILATED AREAS. KEEP VALVE PROTECTION CAP ON CYLINDERS WHEN NOT IN USE .
Other Precautions:PROTECT CONTAINERS FROM PHYSICAL DAMAGE. DO NOT DEFACE CYLINDERS OR LABELS. CYLINDERS SHOULD BE REFILLED BY QUALIFIED PRODUCERS OF COMPRESSED GAS. SHIPMENT OF A COMPRESSED GAS CYLINDER WHICH HAS NOT B EEN FILLED BY THE OWNER OR WITH HIS WRITTEN CONSENT IS A VIOLATION OF FEDERAL LAW (49 CFR)

============= Exposure Controls/Personal Protection =============

Respiratory Protection:IN CASE OF LEAKAGE, USE SELF-CONTAINED BREATHING APPARATUS.
Ventilation:PROVIDE ADEQUATE GENERAL AND LOCAL EXHAUST VENTILATION.
Protective Gloves:NONE
Eye Protection:SAFETY GLASSES.
Other Protective Equipment:SAFETY SHOES WHEN HANDLING CYLINDERS.
Supplemental Safety and Health
VENDOR (CAGE 70123) PART NUMBER: 350005. THIS ENTRY DESCRIBES ONE PART, SERIAL NUMBER XXXXX, ISOBUTYLENE IN AIR, OF A FIELD KIT. SEE THIS SAME NSN, SERIAL NUMBER XXXXX, A 10 HOUR RECHARGEABLE BATTERY

PACK, FOR DATA ON SECOND PART OF KIT.

================== Physical/Chemical Properties ==================

HCC:G3
Vapor Density:.991(AIR=1
Spec Gravity:GAS
Evaporation Rate & Reference:GAS
Solubility in Water:18.68CM3/1@20C
Appearance and Odor:COLORLESS, ODORLESS GAS

================= Stability and Reactivity Data =================

Stability Indicator/Materials to Avoid:YES
OXIDIZING AGENTS.
Stability Condition to Avoid:STABLE UNDER NORMAL STORAGE CONDITIONS. AVOID STORAGE IN POORLY VENTILATED AREAS AND STORAGE NEAR A HEAT SOURCE.
Hazardous Decomposition Products:NONE.
Conditions to Avoid Polymerization:WILL NOT OCCUR.

=================== Toxicological Information ===================

Toxicological Information:LETHAL CONCENTRATION (LC50): NONE ESTABLISHED. LETHAL DOSE 50 (LD50): NOT APPLICABLE. TERATOGENICITY : N/A. REPRODUCTIVE EFFECTS:N/A. MUTGENICITY: N/AP.

===================== Ecological Information =====================

Ecological:NO ADVERSE ECOLOGICAL EFFECTS ARE EXPECTED.

==================== Disposal Considerations ====================

Waste Disposal Methods:DISPOSE OF NON-REFILLABLE CYLINDERS IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS. ALLOW GAS TO VENT SLOWLY TO ATMOSPHERE IN AN UNCONFINED AREA OR EXHAUST HOOD. IF THE CYLINDERS ARE THE REF ILLABLE TYPE, RETURN CYLINDERS TO SUPPLIER WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PRO TECTION CAPS IN PLACE.

=================== MSDS Transport Information ===================

Transport Information:CONCENTRATION: 1 - 1500 PPM. DOT DESCRIPTION (US ONLY): PROPER SHIPPING NAME: COMPRESSED GASSES, N.O.S.; HAZARD CLASS: 2.2 (NONFLAMMABLE); UN 1956; REPORTABLE QUANTITIES: NONE. LABELING: NONFLAMMABLE GAS. ADR/RID (EU ONLY): CLASS 2, 1A. SPECIAL PRECAUTIONS: CYLINDERS SHOULD BE TRANSPORTED IN A SECURE UPRIGHT POSITION IN A WELL VENTILATED TRUCK.

===================== Regulatory Information =====================

SARA Title III Information:THE THRESHOLD PLANNING QUANTIRY FOR THES MIXTURE IS 10,000 LBS.
Federal Regulatory Information:OSHA: PROCESS SAFETY MANAGEMENT: MINOR COMPONENT IS NOT LISTED IN APPENDIX A OF 29 CFR 1910.119 AS A HIGHLY HAZARDOUS CHEMICAL. TSCA: MIXTURE IS NOT LISTED IN TSCA INVENTORY. EU NUMBER: N/A. NUMBER IN ANNES 1 OF DIR 67/548: MIXTURE IS NOT LISTED IN ANNES 1. EU CLASSIFICATION: N/AP. R: 20; S: 9.

Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever, expressly or implied, warrants this information to be accurate and disclaims all liability for its use. Any person utilizing this document should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation.

3251 Bath Pike
Nazareth, PA 18064

MATERIAL SAFETY DATA SHEET

Section 1 - IDENTIFICATION

Product Name: Portland Cements

CAS Reg. No.: 65997-15-1

Chemical Name and Synonyms: Portland Cement, Cement, Hydraulic Cement

Trade Names: Portland Cement – Types I, IA, II, III, IIIA, GU, MS, HE; SAYLOR'S® Portland Types: I, IA, II, III; PRONTO®, Flamingo Brixment® White Portland Cement; Oil Well Cement Class A, H.

MSDS Information: This MSDS supersedes prior MSDS's for the products noted above. This MSDS covers a number of products with similar applications and occupational exposure hazards. Specific constituents and methods of preparation for these products will vary. The term "Portland Cement", used in the text of this MSDS, refers to the above named products collectively.

Chemical Family: Calcium silicate compounds; calcium compounds containing iron and aluminum; and gypsum are the primary constituents of these products.

Informational Phone Numbers: (800) 437-7762 Customer Service - Nazareth, PA
(800) 336-0366 Customer Service - Speed, IN
(800) 624-8986 Customer Service - Martinsburg, WV
(800) 386-2111 Customer Service - Mississauga, ONT

Emergency Contact Information: (800)-424-9300 Chemtrec

MSDS Prepared by: Essroc MSDS Development Committee - (610) 837-6725 – May 18, 2010

Section 2 - COMPONENTS

Hazardous Ingredients:

Component	CAS No.	OSHA PEL (8-hour TWA)	ACGIH TLV	Other Information
Portland Cement	65997-15-1	15 mg total dust/m^3 5 mg respirable dust/m^3	1.0 mg/m^3 respirable	IDLH: 5000 mg/m^3 LD_{50}: No Data
Gypsum	13397-24-5	15 mg total dust/m^3 5 mg respirable dust/m^3	10 mg/m^3	IDLH: Not Determined LD_{50}: No Data
Limestone	1317-65-3	15 mg total dust/m^3 5 mg respirable dust/m^3	10 mg/m^3	IDLH: Not Determined LD_{50}: No Data
Crystalline Silica (< 0.3%)	14808-60-7	For mineral dusts containing crystalline silica: (10 mg respirable dust/m^3)/(%SiO_2 +2) (30 mg total dust/m^3) /(%SiO_2 + 2)	0.025 mg/m^3 respirable	IDLH: 50 mg/m^3 (twa) LD_{50}: ipr rat LD Lo 400 mg/kg
Notes:				

Trace Elements: Portland cement is made from materials mined from the earth and processed using energy provided by fuels. Trace amounts of naturally occurring potentially harmful chemicals might be detected during chemical analysis. Trace constituents may include calcium oxide (also known as free lime or quick lime), free magnesium oxide, potassium and sodium sulfate compounds, chromium compounds, and nickel compounds.

Section 3 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

Portland Cement is a powder that poses little immediate hazard. A single short-term exposure to the dry powder is not likely to cause serious harm. However, exposure of sufficient duration to wet Portland Cement can cause serious, potentially irreversible tissue (skin or eye) destruction in the form of chemical (caustic) burns, including third degree burns. The same type of tissue destruction can occur if wet or moist areas of the body are exposed for sufficient duration to dry Portland Cement.

POTENTIAL HEALTH EFFECTS

Relevant Routes of Exposure: Eye contact, skin contact, inhalation and ingestion.

Effects resulting from eye contact: Exposure to airborne dust may cause immediate or delayed irritation or inflammation.

Eye contact by larger amounts of dry powder or splashes of wet Portland Cement may cause effects ranging from moderate eye irritation to chemical burns and blindness. Such exposures require immediate first aid (see Section 4) and medical attention to prevent significant damage to the eye.

Effects resulting from skin contact: Discomfort or pain cannot be relied upon to alert a person to hazardous skin exposure. Consequently, the only effective means of avoiding skin injury or illness involves minimizing skin contact, particularly contact with wet Portland Cement. Exposed persons may not feel discomfort until hours after the exposure has ended and significant injury has occurred.

Exposure to dry Portland Cement may cause drying of the skin with consequent mild irritation or more significant effects attributable to aggravation of other conditions. Dry Portland Cement contacting wet skin or exposure to moist or wet Portland Cement may cause more severe skin effects including thickening, cracking, or fissuring of the skin. Prolonged exposure can cause severe skin damage in the form of (caustic) chemical burns.

Some individuals may exhibit an allergic response upon exposure to Portland Cement, possibly due to trace amounts of chromium. The response may appear in a variety of forms ranging from a mild rash to severe skin ulcers. Persons already sensitized may react to their first contact with the product. Other persons may first experience this effect after years of contact with Portland Cement products.

Effects resulting from inhalation: Portland Cement may contain free crystalline silica. Prolonged exposure to airborne free crystalline silica may cause delayed lung injury including silicosis, a disabling and potentially fatal lung disease, and/or other diseases. (also see "Carcinogenic potential" below.)

Inhalation may also aggravate other lung conditions. Exposure to Portland Cement may cause irritation to the moist mucous membranes of the nose, throat, and upper respiratory system. It may also leave unpleasant deposits in the nose.

Effects resulting from ingestion: Although ingestion of small quantities of Portland Cement is not known to be harmful, ill effects are possible especially if larger quantities are consumed. Portland Cement should not be eaten.

Carcinogenic potential: Portland Cement is not listed as a carcinogen by the National Toxicology Program (NTP), International Agency for Research (IARC) or the Occupational Safety and Health Administration (OSHA). However, Portland Cement contains trace amounts of crystalline silica and hexavalent chromium which are classified by IARC and NTP as known human carcinogens.

Medical conditions which may be aggravated by inhalation or dermal exposure:

Pre-existing upper respiratory and lung diseases.

Unusual (hyper) sensitivity to hexavalent chromium (chromium^{+6}) salts.

Section 4 - FIRST AID

Eyes: Immediate flush eyes thoroughly with water. Continue flushing eye for at least 15 minutes including under lids, to remove all particles. Call physician immediately.

Skin: Wash skin with cool water and pH-neutral soap or a mild detergent intended for use on skin. Seek medical treatment in all cases of prolonged exposure to wet cement, cement mixtures, liquids from fresh cement products, or prolonged wet skin exposure to dry cement.

Inhalation of Airborne Dust: Remove to fresh air. Seek medical help if coughing and other symptoms do not subside. ("Inhalation" of gross amounts of Portland Cement requires immediate medical attention.)

Ingestion: Do not induce vomiting. If conscious, have the victim drink plenty of water and call a physician immediately.

Section 5 - FIRE AND EXPLOSION DATA

Portland Cement is not combustible.

Flash Point:	Not applicable	Upper Explosive Limit:	Not applicable
Auto ignition temperature:	Not applicable	Lower Explosive Limit:	Not applicable
Auto ignition temperature:	Not applicable	Extinguishing media:	Not applicable
Hazardous combustion products:	Not applicable	Unusual fire and explosion hazards:	None
Special fire fighting procedures:	Portland Cement poses no fire-related hazards. Self-contained breathing apparatus is recommended to limit exposure to combustion products when fighting any fire.		

Section 6 - ACCIDENTAL RELEASE MEASURES

Collect dry material using a scoop. Avoid actions that cause dust to become airborne. Avoid inhalation of dust and contact with skin. Wear appropriate personal protective equipment as described in Section 8.

Scrape up wet material and place in appropriate container. Allow the material to "dry" before disposal. Do not attempt to wash Portland Cement down drains.

Dispose of waste material according to local, state, and federal regulations.

Section 7 - HANDLING AND STORAGE

Keep Portland Cement dry until used. Normal temperatures and pressures do not affect the material. Promptly remove dusty clothing or clothing which is wet with cement fluids and launder before reuse. Wash thoroughly after exposure to dust or wet cement mixtures or fluids.

Section 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

Skin protection: Prevention is essential to avoid potentially severe skin injury. Avoid contact with unhardened (wet) Portland Cement products. If contact occurs, promptly wash affected area with soap and water. Where prolonged exposure to unhardened Portland Cement products might occur, wear impervious clothing and gloves to eliminate skin contact. Where required, wear boots that are impervious to water to eliminate foot and ankle exposure.

Do not rely on barrier creams. Barrier creams should not be used in place of gloves.

Periodically wash areas contacted by dry Portland Cement or by wet cement or fluids with a pH neutral soap. Wash again at the end of the work. If irritation occurs, immediately wash the affected area and seek treatment. If clothing becomes saturated with wet cement, it should be removed and replaced with clean dry clothing.

Respiratory protection: Avoid actions that cause dust to become airborne. Use local or general ventilation to control exposures below applicable exposure limits.

Use NIOSH/MSHA-approved (under 30 CFR 11) or NIOSH-approved (under 42 CFR 84) respirators in poorly ventilated areas, if an applicable exposure limit is exceeded, or when dust causes discomfort or irritation.

Ventilation: Use local exhaust or general dilution ventilation to control exposure within applicable limits.

Eye protection: When engaged in activities where cement dust or wet cement could contact the eye, wear safety glasses with side shields or goggles. In extremely dusty environments and unpredictable environments, wear unvented or indirectly vented goggles to avoid eye irritation or injury. Contact lenses should not be worn when working with Portland Cement or fresh cement products.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Grey, white powder	Odor:	No distinct odor
Physical state:	Solid (powder)	pH (in water):	12 to 13
Solubility in water:	Slightly soluble (0.1 to 1.0%)	Vapor pressure:	Not applicable
Vapor density:	Not applicable	Boiling point:	Not applicable (>1000^{O} C)
Melting point:	Not applicable	Specific gravity (H_2O=1.0):	2.80 - 3.00
Evaporation Rate:	Not applicable	Coefficient of oil to water distribution:	Not applicable

Section 10 - STABILITY AND REACTIVITY

Stability: Stable

Conditions to avoid: Unintentional contact with water.

Incompatibility: Wet Portland Cement is alkaline. As such it is incompatible with acids, ammonium salts and aluminum metal.

Hazardous decomposition: Will not spontaneously occur. Adding water results in hydration and produces (caustic) calcium hydroxide.

Hazardous polymerization: Will not occur.

Section 11 - TOXICOLOGICAL INFORMATION

Route of Entry..Section 3
Effects of acute exposure to product...........Section 3
Effects of chronic exposure to product........Section 3
Exposure Limits..Section 2
Irritancy of product......................................Section 3
Sensitization to product ....Section 3
Carcinogenicity...Section 3
Reproductive Toxicity.................................Not Applicable
Teratogenicity...Not Applicable
Mutagenicity...Not Applicable
Toxicologically synergistic products............Section 3, Section 16

For a description of available, more detailed toxicological information, call one of the informational phone numbers listed at the end of Section 1.

Section 12 - ECOLOGICAL INFORMATION

Ecotoxicity: No recognized unusual toxicity to plants or animals.

Relevant physical and chemical properties: See sections 9 and 10.

Section 13 - DISPOSAL

Dispose of waste material according to local, state, and federal regulations. (Since Portland Cement is stable, uncontaminated material may be saved for future use.)

Dispose of bags in an approved landfill or incinerator.

Section 14 - TRANSPORTATION DATA

Hazardous materials description/proper shipping name: Portland Cement is not hazardous under U.S. Department of Transportation (DOT) regulations.

Hazard class: Not applicable.

Identification number: Not applicable

Required label text: Not applicable.

Hazardous substances/reportable quantities (RQ): Not applicable

Section 15 - OTHER REGULATORY INFORMATION

Status under USDOL-OSHA & MSHA Hazard Communication Standards (29CFR 1910.1200 & 30CFR Part 47): Portland Cement is considered a “hazardous chemical” under these regulations, and should be part of any hazard communication program.

Status under CERCLA/Superfund, 40 CFR 117 and 302: Not Listed

Hazard Category under SARA TITLE III, Sections 311- 312: Portland Cement qualifies as a “hazardous substance” with delayed health effects.

Status under SARA Title III, Section 313: This product contains NONE of the substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372 in concentrations above deminimis levels.

Toxic Substance Control Act (TSCA): Some substances in Portland Cement are on the TSCA inventory list.

Status under the Federal Hazardous Substances Act: Portland Cement is a “hazardous substance” subject to statutes promulgated under the subject act.

Status under Canadian Environmental Protection Act: Not listed.

Status under WHMIS: Portland Cement is considered to be a hazardous material under the Hazardous Products Act as defined by the Controlled Products Regulations (Class D2A – Materials causing other toxic effects and Class E - Corrosive material) and is therefore subject to the labeling and MSDS requirements of the Workplace Hazardous Materials Information System (WHMIS).

SECTION 16 - OTHER INFORMATION

Abbreviations:

ACGIH	American Conference of Government Industrial Hygienists
ASTM	American Society of Testing Materials
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
DOT	Department of Transportation
IARC	International Agency for Research
IDLH	Immediately dangerous to life and health (NIOSH).
m^3	cubic meter
mg	Milligram
mm	millimeter
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicity Program
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
RQ	Reportable Quantities
SARA	Superfund Amendments and Reauthorization Act
TLV	Threshold Limit Value
TWA	Time Weighted Average
URT	Upper Respiratory Tract
WHMIS	Workplace Hazardous Material Information System

Other important information:

Portland Cement should only be used by knowledgeable persons. A key to using the product safely requires the user to recognize that Portland Cement chemically reacts with water, and that some of the intermediate products of this reaction (that is, those present while Portland Cement is “setting”) pose a far more severe hazard than does Portland Cement itself.

While the information provided in this material safety data sheet is believed to provide a useful summary of the hazards of Portland Cement as it is commonly used, the sheet cannot anticipate and provide all of the information that might be needed in every situation. Inexperienced product users should obtain proper training before using this product.

In particular, the data furnished in this sheet do not address hazards that may be posed by other materials mixed with Portland Cement to produce Portland Cement products. Users should review other relevant material safety data sheets before working with this Portland Cement or working on Portland Cement products, for example, Portland Cement concrete.

SELLER MAKES NO WARRANTY, EXPRESSED OR IMPLIED, CONCERNING THE PRODUCT OR THE MERCHANTABILITY OR FITNESS THEREOF FOR ANY PURPOSE OR CONCERNING THE ACCURACY OF ANY INFORMATION PROVIDED BY ESSROC CEMENT CORP., except that the product shall conform to contracted specifications. The information provided herein was believed by Essroc Cement Corp. to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use. Buyer’s exclusive remedy shall be for damages and no claim of any kind, whether as to product delivered or for non-delivery of product, and whether based on contract, breach or warranty, negligence, or otherwise shall be greater in amount than the purchase price of the quantity of product in respect of which damages are claimed. In no event Seller be liable for incidental or consequential damages, whether Buyer’s claim is based on contract, breach of warranty, negligence or otherwise.

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **SAND - ARIZONA SILICA**

Revision Date: 03-Jan-2008

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: SAND - ARIZONA SILICA
Synonyms: None
Chemical Family: Sand
Application: Proppant

Manufacturer/Supplier
Halliburton Energy Services
P.O. Box 1431
Duncan, Oklahoma 73536-0431
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Crystalline silica, quartz	14808-60-7	60 - 100%	0.025 mg/m^3	$\frac{10 \text{ mg/m}^3}{\%SiO_2 + 2}$

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD
May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin	Wash with soap and water.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	None - does not burn.
Special Exposure Hazards	Not applicable.
Special Protective Equipment for Fire-Fighters	Not applicable.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.
Procedure for Cleaning / Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Store in a cool, dry location. Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Product has a shelf life of 36 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.

Respiratory Protection	Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product.
Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Tan
Odor:	Odorless
pH:	Not Determined
Specific Gravity @ 20 C (Water=1):	2.65
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	100
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	0
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	65

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None known.
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.

Inhalation

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Skin Contact

None known.

Eye Contact

May cause mechanical irritation to eye.

Ingestion

None known

Aggravated Medical Conditions

Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Other Information

For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity: Not determined

Dermal Toxicity: Not determined

Inhalation Toxicity: Not determined

Primary Irritation Effect: Not determined

Carcinogenicity Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).

Genotoxicity: Not determined

Reproductive / Developmental Toxicity: Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air) Not determined

Persistence/Degradability Not applicable

Bio-accumulation Not Determined

Ecotoxicological Information

Acute Fish Toxicity: Not determined
Acute Crustaceans Toxicity: Not determined
Acute Algae Toxicity: Not determined

Chemical Fate Information Not determined

Other Information Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR Not restricted

Air Transportation

ICAO/IATA Not restricted

Sea Transportation

IMDG Not restricted

Other Shipping Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory.
WHMIS Hazard Class	D2A Very Toxic Materials Crystalline silica

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.
Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

SSCs

THIS PAGE INTENTIONALLY LEFT BLANK

Subsurface Clearance Field Process Checklist

ERM

Site/Project Name:	Southern PEO / GW Barrier Wall Installation
Client:	MMGL, Corporation
ERM Project No.:	0283866
SSC Exp. Person:	Justin Dauphinais

Project Information Utilized for Field SSC Activities	**Yes**	**No**	**N/A**	**Comments**
Contact Person requested and identified				
Subcontractors prequalified and approved				
ERM / client SSC requirements have been communicated to all field personnel (including subcontractors)				
As-built drawings, site plans, aerial photographs, and/or other information sources available and reviewed				
Site Plan(s) / Drawing(s) developed showing subsurface lines/structures, Critical Zones, and planned Ground Disturbance Locations				
SSC Experienced Person with current SSC training assigned				
Project staff with current SSC training assigned				
UXO / MEC risks assessed: UXO / MEC is present or potentially present				If Yes, stop work and contact PIC

General Field Activity & Site Walk	**Yes**	**No**	**N/A**	**Comments**
HASP available, reviewed, and signed by project team				
Site walk Visual Clues / site features (below) integrated into Site Services Model				

Identified Visual Clue	**Yes**	**No**	**Identified Visual Clue**	**Yes**	**No**
Lights			Pipeline markers		
Signage			Fire hydrants		
Sewer drains / cleanouts			Sprinkler systems		
Cable markers			Water meters		
Utility poles with conduit leading to the ground			Natural gas meters		
Utility boxes			UST fill ports and vent pipes		
Manholes			Equipment locations		
Pavement scarring			Steam lines		
Distressed vegetation or vegetation in linear pattern			Remote buildings with no visible utilities		

Comments / Others:

Contact Person Approval of Ground Disturbance at All Locations (indicate verbal approval by printing "Verbal" in the signature space)			
Name (Print)	Company	Name (Sign)	Date / Time

Utility Markouts	**Yes**	**No**	**N/A**	**Comments**
Public Utility Markouts completed (where available; waiver required if "NO")				
List utilities notified:				
Responses received from ALL companies notified?				
Private Utility Markout completed (waiver required if "NO")				
Performed by:				
Type of equipment/methods used:				
Note any limitations (e.g., sources of interference, geology, etc.):				
Final Critical Zone determinations made by the SSC EP				

Subsurface Clearance Field Process Checklist

Site/Project Name:	Southern PEO / GW Barrier Wall Installation
Client:	MMGL, Corporation
ERM Project No.:	0283866
SSC Exp. Person:	Justin Dauphinais

Critical Zones

Are there any ground disturbance locations <u>known</u> or <u>suspected</u> to be inside Critical Zones?

☐ **Yes.** PIC and BU MP (or designee) must BOTH grant waiver for work within the Critical Zone. The SSC Location Disturbance Permit or equivalent is required for those locations.

☐ **No.** Physical Clearance will proceed to the deeper of: 0.6 m / 2 feet below the frost line or 1.5 m / 5 feet below ground level, whichever is deeper.

Overhead Clearance	Yes	No	N/A	Comments
Overhead utility lines in the general vicinity of ERM work onsite?				
If overhead utilities are present, has nominal voltage been determined? If yes, list in comments section.				Voltage:
Overhead clearances confirmed with equipment operators for safely deploying equipment to the location? (The minimum horizontal distance from any point on the equipment to the nearest overhead electrical power line should adhere to the minimum clearance requirements stipulated by regulation, utility companies, client requirements, and/or industry best practice.)				Clearance distance(s):
Proximity alarms and /or spotters necessary to ensure safe clearances?				
If the equipment is closer than the minimum clearance distance to the overhead utility, can utility be de-energized via formal lockout/tagout (LOTO) program?				
If utility cannot be de-energized, alternate plan developed with approval from the PIC and client/site owner?				

Clearance for Point Disturbances	Yes	No	N/A	Comments
Physical Clearance technique used (waiver required if no Physical clearance performed)				Specify:
Diameter of physical clearance at least 125% larger than outside diameter of largest downhole tool (150% is best practice)				
Physical Clearance successfully completed at all locations				

Clearance for Excavations	Yes	No	N/A	Comments
Communicate excavation plan and Excavation Buffer location(s) to subcontractor. Delineate excavation buffers.				
There are disturbance locations known or suspected to be inside Critical Zones				
De-energize subsurface services via formal LOTO program prior to beginning excavation				

Additional Notes:

SSC Process Completed By (SSC Experienced Person)

Name (Print)	Name (Sign)	Date / Time

Subsurface Clearance Location Disturbance Permit

Disturbance Location Designation:

ERM Project No.: 0283866

SSC Exp. Person: Justin Dauphinais

Contact Person Approval of Ground Disturbance Locations (indicate verbal approval by printing "Verbal" in the signature space)

Name (Print)	Company	Name (Sign)	Date / Time

Critical Zone Determination and Clearance Depth (It is not preferred to initiate Ground Disturbance Activities within a Critical Zone)

If the Disturbance Location is known or suspected to fall within a Critical Zone, then a sketch (see reverse) or other map **must be** used to confirm proximal Critical Zones. Sketch / map must be to scale.

This Location Is:

☐ Inside a Critical Zone. Partner-in-Charge (PIC) and Business Unit Managing Partner (BU MP) must BOTH grant waiver for disturbance at this location. Ensure documentation in the SSC Project Plan addendum to the HASP. Physical Clearance for point disturbances will proceed to the deeper of: **0.6 m / 2 feet below the frost line, 0.6 m / 2 feet deeper than the expected invert elevation of the service, OR 2.4 m / 8 feet below ground level.**

☐ Outside a Critical Zone.
Physical Clearance for point disturbances will proceed to the deeper of: **0.6 m / 2 feet below the frost line or 1.5 m / 5 feet below ground level.**

Physical Clearance Technique at This Location

☐ Cleared using the following techniques / equipment:

Clearance depth and diameter (specify units):

☐ None – or not completed to required depth or diameter. For point disturbances, this must be waived by PIC and BU MP.
(Ensure documentation in the SSC Project Plan addendum to HASP.)

Reason: Date / Time:

Physical Clearance Executed & Observed By:

Company	**Representative(s)**	**Date / Time Complete**	**Notes**

Was any Subsurface Structure discovered (damaged or undamaged) during Clearance?

☐ No (Proceed) ☐ Yes If Yes: Work stopped and discussed with PIC (Date / Time):

Agreed Action:

SSC Process Complete

Name of SSC Experienced Person (Print)	Name (Sign)	Date / Time

Critical Zone Determination Sketch (use this or other map to confirm proximal Critical Zones).

Instructions:

1. Create a sketch of the disturbance (in the space to left or attach) that is drawn to scale and contains the following information:
   a. The disturbance location
   b. Surface landmarks and overhead obstructions (buildings, roads, overhead lines, etc.)
   c. Critical landmarks and Subsurface Structures (tanks, transformers, wells, racks, etc.)
   d. Underground services:
      i. Identified in the Site Service Model
      ii. Marked by Public and Private utility markouts
      iii. As relayed by the Contact Person
      iv. Nearest shutoff / isolation mechanism for each
   e. Any surface clues as to potential underground services (junction boxes, drains, disturbed concrete, signage, etc.)
   f. The site property boundary

2. Use your sketch to mark Critical Zones (3m or 10 feet) around critical landmarks and underground structures / services.

3. For Excavations, use your sketch to mark Excavation Buffers (0.6m or 2 feet) from Subsurface Structures.

4. If the disturbance location falls inside the Critical Zone, the preferred course of action is step out to a safe location outside a Critical Zone.

5. Disturbance within a Critical Zone can only proceed with both PIC and BU MP (or designee) approval.

Subsurface Clearance (SSC) Field Audit Form

Site Name:	Southern PEO Groundwater Barrier Wall
Client:	MMGL, CORPORATION
ERM Project No.:	0283866
Activities Observed on Site:	

1.0	OFFICE / PRE-MOBILIZATION	YES	NO	N/A	N/O	COMMENTS (Refer to Follow-Up Items if needed)
1.1	Have subcontractor(s) working at the project site been pre-qualified and approved by ERM?	☐	☐	☐	☐	
1.2	Has an SSC "Experienced Person" been assigned to manage SSC activities and identified in the site HASP?	☐	☐	☐	☐	
1.3	Have all ERM staff at project site received SSC training? (record names & dates)	☐	☐	☐	☐	
1.4	Are "SSC mentee(s)" working at the site and identified in the site HASP?	☐	☐	☐	☐	
1.5	Have the Level 2 HASP and SSC Project Plan been completed?	☐	☐	☐	☐	
1.6	Has a knowledgeable site contact person been identified? Are they present to participate in site walk and approve disturbance locations?	☐	☐	☐	☐	
1.7	Have available as-builts, maps, aerial photos, etc. been obtained and reviewed?	☐	☐	☐	☐	
1.8	Other:	☐	☐	☐	☐	

2.0	FIELD ACTIVITIES: PRE-CLEARANCE	YES	NO	N/A	N/O	COMMENTS (Refer to Follow-Up Items if needed)
2.1	Are ground disturbance locations/points clearly marked?	☐	☐	☐	☐	
2.2	Have public and private utility locate and markout have been conducted? By who? When?	☐	☐	☐	☐	
2.3	If utility locate/markout was conducted by ERM staff, how is employee qualified to execute locate service? Provide details of training/qualifications.	☐	☐	☐	☐	
2.4	If utility locate/markout was conducted by ERM staff, has location equipment been adequately maintained and calibrated? Provide date of last calibration.	☐	☐	☐	☐	
2.5	Has the ERM *SSC Checklist & Disturbance Permit* been utilized to assess **each** ground disturbance location?	☐	☐	☐	☐	
2.6	Have Critical Zones been identified on the *Site Services Model* and marked?	☐	☐	☐	☐	
2.7	If UXO/MEC are known or suspected to be present, has the site been assessed by a UXO/MEC specialist?	☐	☐	☐	☐	
2.8	Are any Process Waivers being applied? If so, is PIC and BU MP approval documented?	☐	☐	☐	☐	
2.9	Other:	☐	☐	☐	☐	

3.0	FIELD ACTIVITIES: PHYSICAL CLEARANCE	YES	NO	N/A	N/O	COMMENTS (Refer to Follow-Up Items if needed)
3.1	Has Critical Zone (CZ) distance* has been effectively maintained during project?	☐	☐	☐	☐	
3.2	Was physical subsurface clearance to minimum requirements** executed? What methods/equipment were used?	☐	☐	☐	☐	
3.3	If project is a trench or excavation, was the minimum 2-foot (0.6 meters) buffer zone maintained around exposed lines?	☐	☐	☐	☐	
3.4	Was mechanical equipment used within 2-foot (0.6 meters) buffer zones?	☐	☐	☐	☐	
3.5	Have SSC-related safety events been reported per ERM *Subsurface Clearance Procedure*?	☐	☐	☐	☐	
3.6	Were any changes from HASP / SSC Plan observed? If so, were Management of Change procedures implemented per ERM *Subsurface Clearance Procedure*?	☐	☐	☐	☐	
3.7	Other:	☐	☐	☐	☐	

N/A = Not applicable to this project.

N/O = Not observed during audit.

* *Critical Zone - 10 feet (3 meters) distance from all known or suspected underground lines, edge of tanks, pump islands, pump gallery, manifold, electrical transformer, compressor, production well, loading rack, or other process equipment with associated underground lines.*

** *Clearance must meet or exceed 125% the outside diameter of the largest downhole tool. In Critical Zones, physical clearance to 2 feet (0.6 meters) below frost line; OR 2 feet (0.6 meters) deeper than expected invert depth of service or 8 feet (2.4 meters). In Non-Critical Zones, physical clearance to 2 feet (0.6 meters) below frost line; OR 5 feet (1.5 meters)*

FOLLOW UP ITEMS:

- If a checklist item was corrected in the field, please mark as YES and note in the COMMENT area how the correction was implemented.
- If a checklist item was unable to be corrected in the field, please list below the follow-up items for ERM/Client/Sub-Contractor to implement to correct the deficiency or improve the process.

Follow Up Items:

Attach additional comments, as necessary, to a new page.

Prepared By: ______________________________
(print)

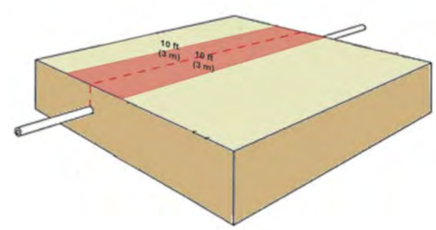
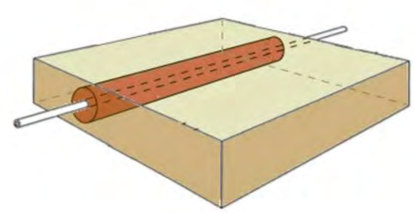
Reviewed By: ______________________________
(print)

____
(print)

Subsurface Clearance (SSC)
Field Review Checklist for Contractors

Site Name:	Southern PEO Groundwater Barrier Wall
Client:	MMGL, CORPORATION
ERM Project No.:	0283866
Contractor activities to be performed on Site:	

Use this form to conduct and document review with contractor field personnel, to ensure they have been properly briefed on the applicable components of ERM's SSC Process.

TOPIC	REVIEWED	N/A	COMMENTS
All personnel on ERM projects are empowered to stop work, without fear of reprimand, if it is unsafe to proceed or if there are concerns or questions.	☐	☐	
If at any time during project execution, the scope of work or jobsite conditions change, work should be stopped and the potential H&S effect of the change discussed.	☐	☐	
Ground disturbance activities may NOT be performed at any location without authorization by the ERM SSC Experienced Person (EP). Clearance activities may NOT be performed at any location unless the ERM EP is physically present.	☐	☐	
Unless explicitly authorized by ERM's Partner-in-Charge and Business Unit Managing Partner, ground disturbance may NOT be performed within 10 feet (3 meters) distance (referred to as the "Critical Zone") of the surface projection of: • Any known or suspected underground pipes, cables, conduits, drains, galleries, edges of tanks, or any other useful property; or • Aboveground structures with associated subsurface pipes and/or cables, including but not limited to pump islands, pump galleries, manifolds, electrical transformers, compressors, production wells, loading racks, or other process equipment.	☐	☐	**"The Critical Zone"** 
Unless authorized by the ERM EP, ground disturbance / clearance activities must NOT be performed in areas that are in direct conflict with any markings made by public or private utility locators.	☐	☐	
Unless explicitly authorized by ERM's Partner-in-Charge and Business Unit Managing Partner, all borehole and small test pit locations must be physically cleared prior to use of mechanized equipment. Required physical clearance depths and diameters for point disturbances are as follows: • Physically clear to a diameter at least 125% of the largest downhole tool to be used. • Physically clear to the deeper of: o 2 feet (0.6 meters) beyond the bottom of the frost line at the site, or: o Outside Critical Zones to 5 feet (1.5 meters), or o Inside Critical Zones to the deeper of: 8 feet (2.4 meters), or 2 feet (0.6 meters) deeper than the expected invert elevation of the subsurface structure.	☐	☐	**"The Excavation Buffer"** 

TOPIC	REVIEWED	N/A	COMMENT:
Mechanical digging is prohibited inside a 2-foot (0.6-meter) distance (referred to as the “Excavation Buffer”) in all directions from subsurface structures that will be intentionally exposed due to ground disturbance activities. Removal of material inside the Excavation Buffer may only proceed by hand using non-conductive tools.	☐	☐	
For all equipment brought to the site, the minimum horizontal distance from any point on the equipment to the nearest overhead electrical power line must adhere to the minimum safe clearance requirements stipulated by regulation, utility companies, client requirements, and/or industry best practice.	☐	☐	
If subsurface structures are to be de-energized prior to ground disturbance activities, only trained personnel may do so via a formal, written energy isolation program.	☐	☐	
Contractor personnel should be observant during ground disturbance activities for the presence of warning signs indicating non-native soil, fill materials, and/or the presence of unexpected subsurface structures. Any evidence of warning signs, unexpected encounters with subsurface structures, or any other near misses or incidents must be immediately reported to the ERM EP or field supervisor. Contractor personnel must participate, as requested, in investigations of near misses and incidents.	☐	☐	
Other topics discussed:	☐	☐	

N/A = Not applicable to this project.

REQUIREMENTS FOR TOOLS AND EQUIPMENT:

- Hand digging tools must have a non-conductive handle (e.g., fiberglass, wood, composite) AND / OR fully insulated handles and upper shaft. It is a best practice to also wear insulated electrical gloves certified to appropriate standards.
- Blades on shovels and post-hole diggers must have rounded or blunt edges.
- Pick axes or pointed spades are not to be used for physical clearance.
- Electric-powered equipment must have ground fault protection. If this is not feasible, fully insulated electrical gloves certified to appropriate standards must be worn at all times during equipment use/operation.
- Equipment must be inspected prior to use, maintained according to manufacturer recommendations, and operated only by trained personnel.
- Rig- or stand-mounted concrete coring equipment must be anchored to the ground/floor using proper anchors.

Checklist Completed By: (SSC Experienced Person)		
Name (Print)	Name (Sign)	Date / Time

Reviewed By: (All Contractor Personnel)		
Name (Print)	Name (Sign)	Date / Time

This Subsurface Clearance (SSC) Project Plan should be completed for each phase of ground disturbance activities at a project location, and included as an addendum to the Project-Specific Level 2 WARN Health & Safety Plan (HASP).

Ground disturbance activities that fall under this SSC Project Plan include ALL activities which require penetration of the ground surface deeper than 1 foot (0.3 meter), AND/OR the coring or removal of engineered surfaces (pavement, concrete, etc.). Examples of Ground Disturbance Activities include, but are not limited to:

- Hand digging
- Hand augering
- Drilling
- Direct-push or Geoprobe® borings
- Well installation
- Well decommissioning by over-drilling
- Excavation (by hand or with mechanical equipment)
- Trenching
- Grading
- Concrete coring
- Driving of posts, stakes, rods, poles, or sheet pile.

This SSC Project Plan summarizes the types and sources of SSC information obtained, describes the Site Services Model, and documents any waivers to ERM's Global SSC Process. The ERM Partner-in-Charge (PIC), Project Manager (PM), and SSC Experienced Person (EP)[1] must review and approve this SSC Project Plan, and maintain a copy (1) at the project location for the duration of ground disturbance activities and (2) in the project files.
All waivers must be approved by BOTH: (1) the ERM PIC and (2) the Business Unit Managing Partner (BU MP) or the BU MP's designee (cannot be the same person as the PIC).

<table>
<tr><td rowspan="6">Administrative Information</td><td colspan="2">Project Name and Location: Southern PEO Site, 10400 N. Burgard Way, Portland Oregon</td></tr>
<tr><td colspan="2">Scope of Ground Disturbance Activities: Coring of up to 8 locations, Air knife and vacuum clearance of twelve to sixteen borings, Installation of twelve to sixteen boring via direct push methods.</td></tr>
<tr><td><u>Check all that apply:</u>
☒ Point disturbances
☒ Excavation / trenching
☐ Removal of engineered surfaces
☐ Other
Describe:</td><td>Use field documentation to document SSC:
• Process Checklist – broadly across the site
• Remote/Greenfield Site Process Checklist – broadly across the site for those projects that meet these criteria and where ONLY hand digging will occur (refer to SSC Process Document Section 1.2)
• Location Disturbance Permit – for each location inside a Critical Zone</td></tr>
<tr><td>SSC Project Plan Date: 08/07/2015</td><td>Field Work Start Date: 09/21/2015</td></tr>
<tr><td>Project Manager: Brendan Robinson
Signature:</td><td>Partner In Charge: Erik Ipsen
Signature:</td></tr>
<tr><td>SSC EP: Justin Dauphinais
Signature:</td><td>BU MP (req'd for waivers):
Signature:</td></tr>
</table>

[1] SSC EP not required for project sites determined to be Remote/Greenfield sites (as defined in the ERM Global SSC Process), where ONLY hand digging will occur.

	List any SSC General Employees (GEs) working on this project: Melody Kieneker, Shira DeGrood

Subsurface Clearance Information Sources Summary **Document the information sources that ERM used or will use to locate Subsurface Structures on site.**	**Information Sources**	**Yes**	**No**	**N/A**	**Comments**
	Facility-provided as-built drawings, maps, site plans showing subsurface structures / utilities	☐	☒	☐	Date(s):
	Other information obtained (e.g., easements, right-of-ways, historical plot plans, current/historical aerial photographs, fire insurance plans, tank (dip) charts, SSC information obtained as part of previous site investigations, soil surveys, boring logs	☒	☐	☐	List (including dates): City of Portland Maps 2015
	Knowledgeable Contact Person	☒	☐	☐	Who: Tom Graf Time in Job: Time at Site:
	Utility Markouts	**Yes**	**No**	**N/A**	**Comments**
	Site is Remote/Greenfield site AND only hand digging will occur	☐	☒	☐	*If "YES", utility markouts are not required by ERM process (Note that public markouts may be legally required based on jurisdiction of project site – it is the responsibility of the PIC and PM to determine these requirements and comply)*
	Public Utility Markouts (where they are available)	☒	☐	☐	*Required where available – if not available check "N/A". If available and checked "NO", a Waiver is required (if legally able to do so).* Who: Oregon Utility Notification Center
	Private Utility Mark outs	☒	☐	☐	*If checked "NO" and site is not a Remote/Greenfield site, a Waiver is required* ERM employee ☐ or Subcontractor ☒ Who: Geopotential List methods / equipment used: GPR, CAT, Tracer, Magnetometer, Metal Detector.

For Remote/Greenfield Sites where ONLY hand digging will occur – the remaining sections of this SSC Project Plan do not apply and can be left blank.

Site Services Model

List the utilities or other below ground services present on site.

Do we know the locations of these services, their conveyance on site (to the site boundary, as appropriate) and the location of isolation switches or valves?

If “Present” and not located or “Unknown”, comment on how those gaps will be addressed.

Attach a site plan / drawing (to scale) showing planned ground disturbance location(s), the locations/routes of all identified or suspected subsurface structures and services, and associated critical zones.

Utility / Service	**Present**	**Anticipated Depth (note units)**	**Located?**		**Absent**	**Unknown**	**Status (active/ inactive/ abandoned)**	**Comment** *(how located? Lines of evidence – types and quality. How will gaps be addressed?)*
			Yes	No				
Electricity	☒		☒	☐	☐	☐		Voltage:
Gas	☒		☐	☒	☐	☐		
Petroleum Pipeline	☒		☒	☐	☐	☐		
Other Pressurized Lines	☒		☒	☐	☐	☐		
Process Sewer	☐		☐	☒	☐	☒		
Sanitary Sewer	☒		☒	☐	☐	☐		
Storm Sewer	☒		☒	☐	☐	☐		
Potable Water	☒		☒	☐	☐	☐		
Telephone / Communication	☐		☐	☒	☐	☒		
Fiber Optic	☐		☐	☒	☐	☒		
Plant air / steam	☒		☒	☐	☐	☐		
Fuel / oil	☐		☐	☒	☐	☒		
Reclaimed / waste water	☐		☐	☒	☐	☒		
Fire suppression	☒		☒	☐	☐	☐		
Underground tank(s)	☐		☐	☒	☐	No		N/A
Other:	☐		☐	☐	☐	☐		

Subsurface Clearance Process Waivers	Process Component Being Waived:	Waived By (PIC)	Waived by (BU MP)	Date	Reason
Document any waivers to the process approved by BOTH the PIC and BU MP. **Legally required steps cannot be waived.**	Performance of Public Utility Markouts (where they are available)				
	Performance of Private Utility Markouts				
	No ground disturbance inside a Critical Zone				
	Physical Clearance to required depth(s) and diameters(s) at Point Disturbance Location(s). Indicate specific location(s):				

Subsurface and Overhead Utility Clearance Map	**Attach a site plan / drawing (to scale) showing planned ground disturbance location(s), the locations/routes of all identified or suspected subsurface structures and services, associated critical zones, and location of all isolation devices and/or shutoff valves.**

THIS PAGE INTENTIONALLY LEFT BLANK

Attachment D
Groundwater Barrier Wall
Conceptual Design and Setback
(stamped)

THIS PAGE INTENTIONALLY LEFT BLANK

MMGL Corp.

Groundwater Barrier Wall Conceptual Design and Setback Memorandum

Former Premier Edible Oils (PEO) Property
10400 North Burgard Way
Portland, Oregon

September 2015

Project No. 0283866

Erik C. Ipsen, P.E.
Partner-in-Charge

REGISTERED PROFESSIONAL ENGINEER
71118PE
OREGON
MAY 14, 2002
ERIK C. IPSEN
Expires: June 30, 2017

ERM-West, Inc.
1001 SW 5th Avenue; Suite 1010
Portland, Oregon 97204
T: 503-488-5282
F: 503-488-5142

THIS PAGE INTENTIONALLY LEFT BLANK

Memorandum

Environmental Resources Management

1001 SW 5th Avenue
Suite 1010
Portland, OR 97204
(503) 488-5282
(503) 488-5142 (fax)

To: Erin McDonnell, P.E.

Company: Oregon Department of Environmental Quality Northwest Region

2020 SW 4th Avenue, Suite 400

Portland, Oregon 97201

From: Brendan Robinson, ERM

Project Number: 0283866

Date: 4 May 2015

Subject: Groundwater Barrier Wall Conceptual Design and Setback Memorandum

---

ERM-West, Inc. (ERM) has prepared this *Groundwater Barrier Wall Conceptual Design and Setback Memorandum* on behalf of MMGL Corp. (MMGL) for Premier Edible Oils (PEO) property located at 10400 North Burgard Way in Portland, Oregon (the site). The site location is shown on Figure 1. This memorandum was prepared pursuant to the *Voluntary Agreement for Upland Remedial Investigation/Feasibility Study and Source Control Measures*, issued by the Oregon Department of Environmental Quality (ODEQ) and signed 6 March 2001 (ODEQ ECDVC-NWR-01-06) (Voluntary Agreement).

This memorandum presents the results of a geotechnical investigation and the conceptual design of a groundwater barrier wall (GWBW) component of the groundwater source control measure (GW SCM) at the site.

INTRODUCTION

A preliminary geotechnical investigation and engineering evaluation was performed to develop the conceptual design for the GWBW component of the GW SCM. Based on historical investigations and analyses performed to-date, a hanging slurry wall, in conjunction with an air sparging system, has been determined to be a feasible alternative for mitigating potential flow of light non-aqueous phase liquids (LNAPL) and dissolved phase contaminants in groundwater toward the Willamette River. This technical memorandum focuses on developing the GWBW conceptual design. The conceptual design of the sparging system will be presented under separate cover.

The observed extent of LNAPL is from the upland portion of the site and extends to the top of the riverbank (Figure 2). In order to maximize the portion of plume captured, the alignment of the GWBW should be as close to the crest of the riverbank as possible, while maintaining stable and safe conditions during and post-construction.

The objective of this evaluation was to identify the minimum practical offset of the slurry wall alignment from the existing top of bank based on stability and constructability of a slurry wall. It should be noted that the stability analysis presented herein is associated with the stability of the riverbank due to the construction of the slurry wall, and not the stability of the trench walls, as the slurry will support the trench walls.

An approximate offset of the slurry wall was initially estimated based on a preliminary stability analysis. The preliminary alignment was used to determine the approximate location of soil borings installed for the subsurface investigation. The preliminary analysis was revised to incorporate geotechnical field and laboratory data obtained during the subsurface investigation.

SITE CONDITIONS

The ground surface just upland of the riverbank crest is relatively flat, at an elevation between 30 and 32 feet North American Vertical Datum 1988 (NAVD88), and is comprised of an exposed soil and asphalt surface. Groundwater is approximately 20 feet below the upland ground surface at an elevation of approximately 10 feet NAVD88. Based on prior evaluations, the depth of the slurry wall, as considered herein, is assumed to be approximately 50 feet below the ground surface (bgs). The riverbank consists of steep slopes averaging approximately 2 horizontal to 1 vertical (2H:1V). The average water elevation in the river is approximately 8 to 10 feet NAVD88; however, the water level within the river fluctuates. Ordinary high water near the site is approximately 20.5 feet NAVD88. The alignment of the riverbank will require one significant bend in the GWBW.

GEOTECHNICAL EVALUATION

On 17 through 20 February 2015, ERM supervised the drilling of five borings (MR-1 though MR-5) at the site within the general area designated for the GWBW (Figure 2). Soil borings were advanced by Cascade Drilling, Inc. (Cascade) of Portland, Oregon, using a CME-75 mud rotary drill rig. Soil borings were advanced to total depths of 51.5 to 52 feet bgs. Groundwater was encountered between 20 to 21.5 feet bgs during drilling activities.

Boring locations were spaced approximately 100 feet apart within the conceptual alignment corridor of the GWBW. The initial soil boring MR-1 was completed as a pilot boring to determine subsurface conditions and sampling interval depths for borings MR-2 through MR-5.

Split spoon soil samples were collected at approximate 5-foot intervals using standard penetration test (SPT) methods with a 140-pound hammer. SPT blow counts were recorded. Based on field observations, three strata were identified during drilling activities: upper sand, silt, and lower sand. In-situ soil samples were collected for geotechnical analysis using a Shelby tube sampler. A total of eight in-situ soil samples were collected from the three strata (three from an upper sand zone, three from intermittent silt layers, and two from a lower sand zone) and designated with their respective boring location and depth interval (e.g. MR-2-IS-10'). A total of eight bulk soil samples were collected (three from an upper sand zone, three from intermittent silt layers, and two from a lower sand zone) and designated with their respective boring location and depth interval (e.g. MR-2-BS-20-22'). Soil samples were field screened for volatile organic compounds (VOCs) using a photo-ionization detector (PID). Soil samples were logged using the Unified Soil Classification System. The subsurface materials are predominately poorly graded sand with some silt and clay observed between approximately 28 feet bgs and 37 feet bgs. Generally, the subsurface materials throughout the depth of the borings were characterized as medium to fine sand with limited fine-grained soils (i.e., silt and clay). After drilling and sampling activities were complete, borehole locations were backfilled with bentonite chips and were patched, if appropriate, to match surface conditions. Boring logs are provided in Appendix A.

LABORATORY ANALYSIS

A total of 16 samples, including bulk samples and Shelby tube samples, were collected and submitted to JLT Laboratories, Inc. in Canonsburg, Pennsylvania, for geotechnical analyses. Samples submitted for testing were representative of the materials and depths observed in the borings. The laboratory tests performed included the following:

- Particle-size distribution analysis (ASTM International [ASTM] D-422) – sieve only for sand hydrometer was used for silts;
- Soil classification (ASTM D-2487);
- Density (ASTM D-2937);
- Moisture content (ASTM D-2216);
- Atterberg limits (ASTM D-4318); and
- Direct shear strength test (ASTM D-3080).

The laboratory test results are provided in Appendix B; a brief summary of the soil index data results are provided in Table 1 below.

Table 1 A Summary of Geotechnical Laboratory Results

Boring	Depth (ft)	Sample Type	Soil Classification	% Sand (particle size)	Moisture Content (%)	Residual Cohesion (lb/ft^2)	Residual Friction Angle (°)
MR-2	9-10	Shelby	SP	98.1	24.4	43	29.2
MR-2	20-22	Bulk	SP	95.1	26.3	--	--
MR-2	35-36	Shelby	ML	7.4	36.4	--	--
MR-2	40-42	Bulk	SM	83.6	30.9	--	--
MR-3	8-10	Bulk	SP	96.8	14.1	--	--
MR-3	17-18	Shelby	SP	98.5	27.3	44	27.9
MR-3	33-35	Bulk	SM	70.7	37.6	--	--
MR-3	41-42	Shelby	SP	98.8	26.0	279	25.2
MR-4	33-34	Shelby	ML	18.7	39.6	--	--
MR-4	36-38	Bulk	SP	98.6	24.1	--	--
MR-4	48-50	Bulk	SP	98	28.1	--	--
MR-4	50-51	Shelby	SP	99.1	27.5	172	26
MR-5	28-30	Bulk	SM	71.9	33.2	--	--
MR-5	30-31	Shelby	SP	98.2	32.8	76	28
MR-5	32-33	Shelby	ML	30.8	40.8	120	27.7
MR-5	35-37	Bulk	ML	21.9	46.6	--	--

The friction angle is generally consistent across the soils and depths ranging between 25 degrees and 29 degrees. However, cohesion varied between 43 pounds per square foot (psf) and 279 psf, with the lower values observed at shallower depths and higher values at lower depths. Based on SPT blow counts (presented on the soil boring logs in Appendix A), and correlating with the friction angles, the sandy materials are characterized as loose sand.

SLOPE STABILITY ANALYSIS

Based upon the geotechnical laboratory and field data, three soil layers were identified. In descending order, these layers consisted of the following:

- A layer of medium and fine sand material extending to a depth of 30 feet bgs.
- A layer of silt and silty sand material extending from a depth of 30 to 37 feet bgs.
- A layer of fine and medium sand material extending from a depth of 37 feet bgs to the bottom of slurry wall at 50 feet bgs.

Each of these layers of subsurface materials was assigned index properties, including unit weight (moist and saturated) and strength parameters, based on the data from the laboratory analysis. Properties of the slurry wall were estimated based on experience with similar materials. The index properties incorporated in the analysis are presented in Table 2 below.

Table 2 Index Properties

Material Description	Unit Weight (lb/ft^3)	Saturated Unit Weight (lb/ft^3)	Cohesion Intercept (lb/ft^2)	Internal Friction Angle (°)	Soil Type
Sand (top layer)	111	118	54	28	1
Silt and Silty Sand	110	115	113	28	2
Sand	117	125	184	26	3
Slurry Wall	110	120	2	0	4

The following scenarios were considered for stability analysis:

1. Stability of the slope under the existing conditions to verify the parameters that represent a stable slope.
2. Construction of the slurry wall, including the slurry trench and a surcharge load representing the slurry wall trenching machine located a certain distance up-gradient of the top of the bank to identify the minimum slurry wall offset from the bank.
3. Stability following construction of the slurry wall.

Both normal and rapid drawdown conditions were considered for the slurry wall scenarios. Rapid drawdown occurs when the water elevation within the river drops rapidly (i.e., after a storm) but the groundwater elevation remains elevated as it is slower to dissipate. In this scenario, the pore water from saturation of the slope cannot dissipate in the short term and excess pore water pressures exist within the embankment. This condition will reduce the stability of the embankment. Both rapid drawdown and normal river and groundwater conditions were evaluated. Rapid drawdown during slurry wall construction represents the critical condition. For the rapid drawdown condition, the water level in the river was initially considered 10 feet above the normal river water level, to an elevation of 20 feet above mean sea level, then quickly drawn down to normal level. This surface water elevation represents the high water level based on field observation as well as from measurement recorded at United States Geological Survey tidal gauge (ID#14211720) located in the vicinity of the site.

ERM employed STABL 3.0 slope stability software to configure and perform multiple stability analyses for each scenario based on soil parameters and the corresponding geometry. Both rotational and sliding block failures were analyzed. Multiple analyses were conducted to identify the minimum factor of safety acceptable while allowing the closest approach of the slurry wall to the crest of the riverbank. The stability analyses are presented in Appendix C.

Results of Stability Analyses

As indicated above, both deep-seated rotational failure and veneer (sliding block) failure mechanisms were considered within the stability analyses. It was determined that rotational failure was the critical evaluation (i.e., resulted in the lowest factor of safety) for all the scenarios described above.

Under the first scenario, the general stability of the riverbank with no construction loads and normal groundwater conditions was evaluated. It is noted that the factor of safety for the existing riverbank under normal groundwater conditions was less than 1.5, an established industry standard, but greater than 1.0 (imminent failure). Model output for this scenario is presented as Appendix C.1 and C.2 (normal groundwater and rapid-drawdown conditions, respectively)

For the second scenario, it was determined that the outboard edge of the slurry wall should be located a minimum of 20 feet up-gradient (i.e., inland) of the crest of the riverbank. With this minimum requirement, the centerline of a 3-foot wide slurry wall should be 21.5 feet from the crest of the riverbank. When the slurry wall is located 20 feet inland of the crest of the riverbank it is outside of the critical failure surface. Model output for this scenario is presented as Appendix C.3 and C.4 (normal groundwater and rapid-drawdown conditions, respectively).

For the third scenario, the stability of the riverbank following construction of the slurry wall was evaluated. Since the proposed slurry wall alignment is located just beyond the critical failure surface, the long-term stability of the slurry wall does not significantly vary the factor of safety when compared to the existing conditions. Model output for this scenario is presented as Appendix C.5 and C.6 (normal groundwater and rapid drawdown conditions, respectively).

The stability analyses scenarios are summarized in Table 3 below.

Table 3 Stability Analyses Scenarios

	Scenario	**Model Summary** (Normal groundwater conditions)	**Model Summary** (Rapid drawdown conditions)	**Appendix Location of Output** (Normal groundwater conditions)	**Appendix Location of Output** (Rapid drawdown conditions)
1	Existing riverbank	• No construction load • No slurry wall • Critical Factor of Safety = 1.33	• No construction load • No slurry wall • Critical Factor of Safety = 0.98	C.1	C.2
2	During Construction	• Construction load • Slurry wall offset =20 feet • Critical Factor of Safety = 1.33	• Construction load • Slurry wall offset =20 ft • Critical Factor of Safety = 0.98	C.3	C.4
3	Post Construction	• No construction load • Slurry wall offset =20 feet • Critical Factor of Safety = 1.33	• No construction load • Slurry wall offset =20 ft • Critical Factor of Safety = 0.98	C.5	C.6

Slurry Wall Construction

Conventional slurry wall construction requires multiple steps including the excavation of the trench, preparing the slurry, pumping slurry into the trench to hold the trench open, mixing the low permeability backfill (i.e., soil-bentonite backfill) in a designated mixing area, placing the backfill into the trench, and various quality control tests for each stage. A large working area is required for the preparation of the slurry and mixing the backfill. Due to the flowable nature of the backfill, the mixing area is generally sloppy and requires controls to prevent erosion and backfill from unintentionally flowing or falling into the trench. The excavation and backfilling of the trench is largely dependent on the equipment operator's proficiency. The trench slopes at either end should be maintained to enable proper placement of backfill and prevent collapse or buckling of the existing materials. If the excavation and backfilling of the trench is not conducted appropriately, sand lenses or permeable "windows" could be trapped within the slurry wall that enable groundwater flow to more easily pass through the barrier. Refer to Appendix D for a photograph of conventional slurry wall construction.

The primary site-specific constraints include sandy materials which have a higher potential for wall instability, the proximity of the slurry wall to the crest of the riverbank, and a bend located within the area of higher concentrations of contaminants. Maintaining wall stability during construction is dependent on the contractor's excavation techniques and achieving a slurry mix that is sufficient to maintain the open trench.

The construction methodology will affect the reliability and performance of the bend in the wall. There are various construction methods being considered based on discussions with the contractors. The considerations for each construction technique include proximity to the 20-foot top of bank offset at the bend, uncertainty regarding wall stability during construction, and cost. Various slurry wall construction options and their effect on the wall alignment are presented below. It should be noted that the final design should not dictate the means and methods for wall construction; rather, the following descriptions of various methods are for reference purposes as they relate to wall alignment, uncertainties in construction, and cost.

1. **Lead-in/Exit Trench Beyond Turning Point:** A conventional technique to accommodate a turn in a slurry wall is to construct a wall segment, relocate the equipment, and construction of a separate wall segment that intersects at the turning point. To achieve the full depth at the

intersection point, an exit trench for the initial wall segment continues beyond the turning point, and a lead-in trench for the second wall segment begins beyond the turning point. In this manner, an "X" is formed with the intersection of the walls forming the turning point. This method is not considered an acceptable approach at the site, as the lead-in and exit trenches would extend down the riverbank. Construction of a trench in the riverbank reduces the maximum elevation of the slurry and increases potential for slurry to discharge into the river.

2. **Sweeping Bend:** An excavator can accommodate a sweeping bend with a radius between 100 and 150 feet. As a result, the wall alignment at the site would be approximately 18 feet further inland from the turning point and gradually transition to the tangential intersection with the straight wall segment approximately 70 feet from the turning point. Consequently, the wall alignment would concede up to 18 feet further inland to make the bend, as shown on Figure 2. This method allows for continuous trenching without repositioning/relocating the equipment. Further, there is no additional risk or uncertainty associated with constructing the bend relative to the straight-wall segments.

3. **Auger Mixing at Turning Point:** Conventional slurry wall construction will be used for the straight segments up to approximately 50 to 70 feet from the turning point. The equipment will need to be repositioned/relocated to install each segment. Mobilization of in-situ auger soil mixing equipment will be required to construct the turning point. Overlapping auger-mixed soil-bentonite holes would be implemented to achieve a continuous GWBW, including the turn at the designated 20-foot offset from the top of riverbank. In-situ mixing is a proven technology to achieve the objectives of the project. Since the blending of materials is performed in-place (i.e., does not require excavation of a trench and separate backfilling of the trench), this approach is more controlled with less risk of potential wall instability or collapse. However, it is a different process with separate equipment, crews, and quality control measures. The mobilization and use of separate equipment will increase the project cost.

4. **Vertical Trench End Wall at Turning Point:** An alternative technique that has been suggested consists of constructing intersecting vertical endwalls at the turning point. Initially a lead-in trench along one of the line segments would terminate with a vertical endwall at the turning point. The equipment would then be repositioned/relocated to

construct a similar lead-in trench with a vertical endwall at the turning point. The vertical endwall trenches would intersect at the turning point to create the bend. The equipment would be repositioned multiple times to complete the wall. This approach would achieve the intended 20-foot offset from the riverbank. However, there is uncertainty regarding the constructability and performance of the slurry wall with this construction technique regarding the ability to excavate a vertical end wall and ensure it remains stable. There is a potential that a wedge of existing material would remain in the bottom of the trench. If the wedge is removed, the operator must take extreme care to not over excavate the bottom and undercut the intersection point, thereby, creating a reverse slope that will inevitably collapse. There is also a potential that the size of the turning point would increase due to erosion of sands during excavation (i.e., intersecting vertical walls) and/or backfilling. Additionally, soil-bentonite backfill would need to flow around the turning point, potentially inducing erosion of the wall. This method will increase costs relative to the sweeping bend approach. This approach will achieve the designated setback along the bend; however, the uncertainties add inherent risk with additional cost and quality control requirements to ensure successful implementation of this approach.

5. **One-Pass Trenching:** One-pass trenching (OPT) is an alternative technology to conventional slurry wall construction. OPT uses specialized equipment with a large cutting bar (i.e., resembles a large chainsaw) to cut the trench and mix the existing soils with bentonite simultaneously. Bentonite is placed loose at the top of the trench, and bentonite slurry is also pumped through the cutting bar to inject the reagent at depth. Mixing is performed in-situ; therefore, an open trench does not need to be maintained with slurry, and there is less concern associated with wall collapse or instability. OPT also does not require the space or controls needed for mixing, as OPT can be utilized in space-constrained areas. Additionally, OPT has a tight turning radius, which is approximately 40 feet. The most significant limiting factor is the presence of obstructions, such as boulders, concrete foundations, or other impediments. Obstructions were not observed during installation of the geotechnical borings or historical monitoring well installation in the vicinity of the wall alignment. As a result, OPT is a viable technology that can achieve the designated setback. The cost is slightly higher than the sweeping bend option. However, it is competitive with the other conventional slurry wall methods described above. Refer to Appendix D for a photograph of OPT.

CONCLUSION

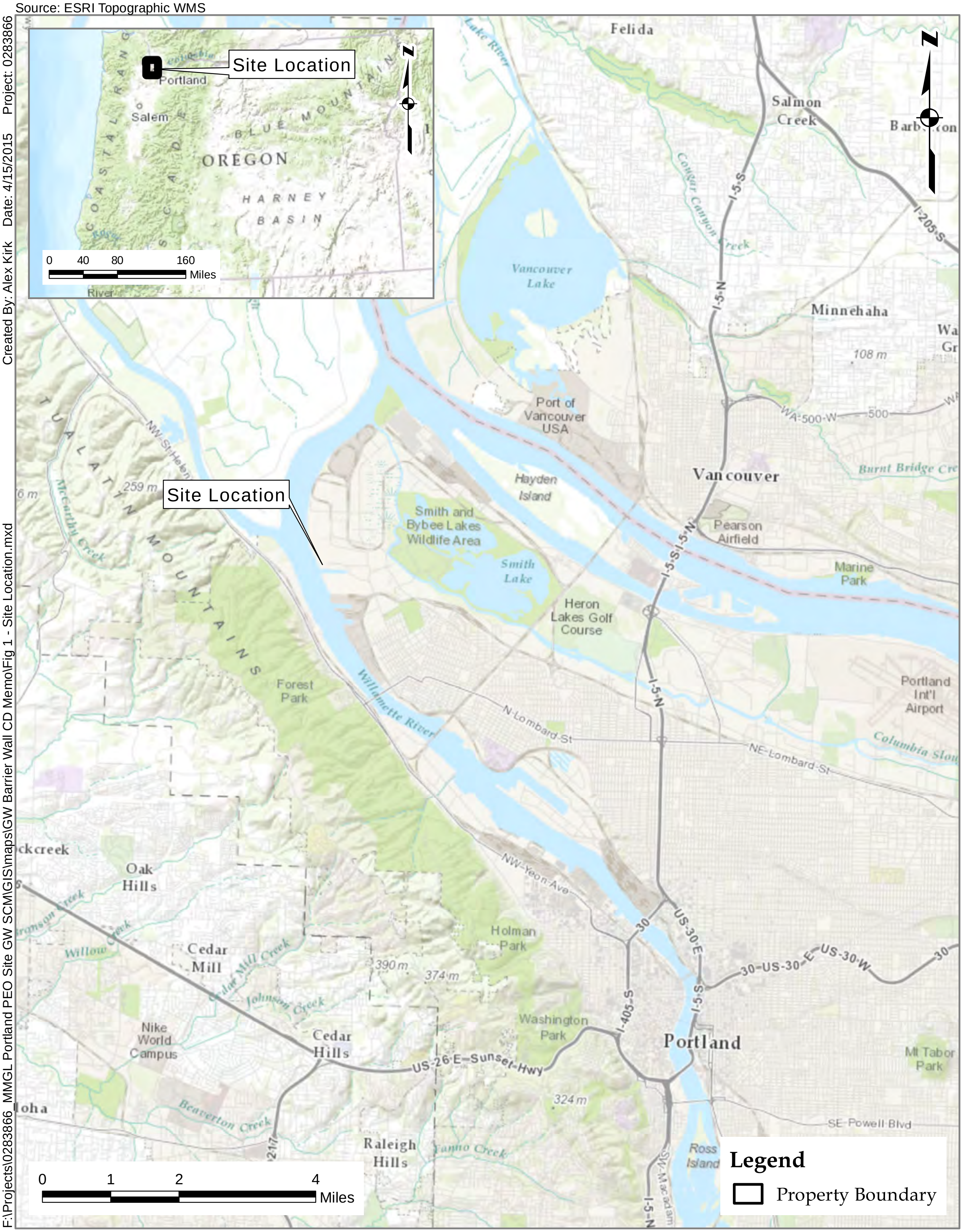
Slurry wall construction has inherent risks and uncertainties, particularly with sandy soils and constructing bends. Wall collapse or sand "windows" are the primary concerns with slurry wall construction. Many of the uncertainties can be managed with an experienced operator and quality control activities. Based on this preliminary geotechnical assessment, the outboard limit of the slurry wall should be offset from the crest of the riverbank by a minimum of 20 feet (for a 3-foot wide slurry wall, the centerline would be 21.5 feet from the crest). The bend can be constructed using conventional slurry wall technology, with an alternative to achieve a bend that is closer to the designated offset. In general, construction costs increase with a bend that is closer to the designated offset. OPT is a feasible alternative construction technology for installing the GWBW.

RECOMMENDATIONS

Prior to preparation of a final GWBW design, further soil and groundwater samples should be collected from the proposed alignment area. Samples will be collected in the areas of known LNAPL and dissolved phase impact and used for slurry compatibility and mix design testing. Results of the slurry compatibility testing will be used in the final design specifications. Additionally, other design elements such as the wall depth and length should be evaluated and presented in the final design specifications.

Figures

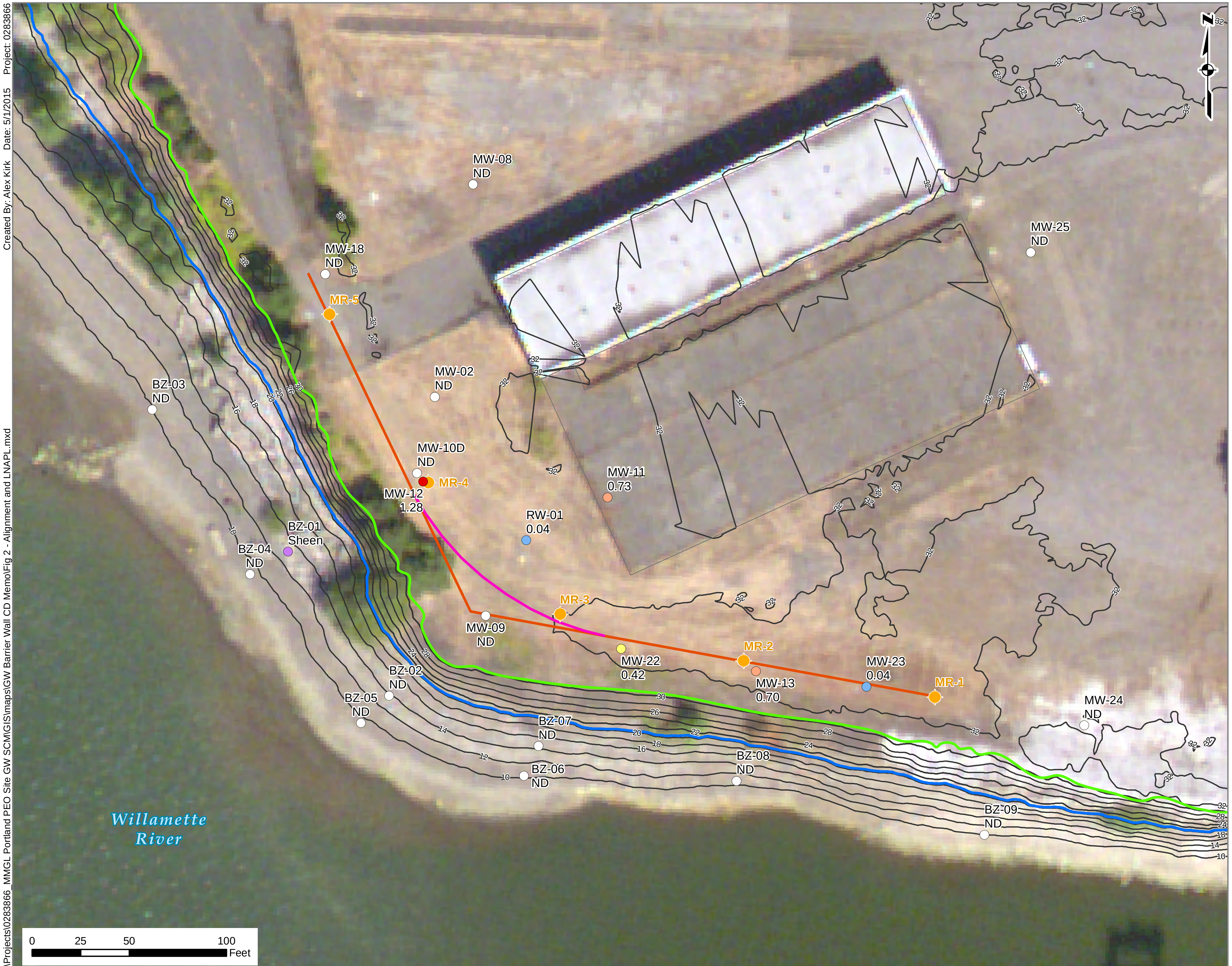
Source: ESRI Topographic WMS

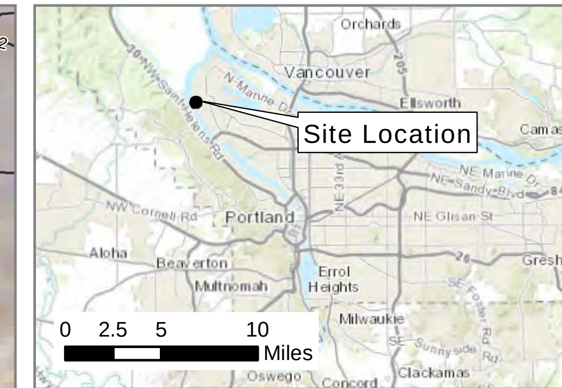


F:\Projects\0283866 MMGL Portland PEO Site GW SCM\GIS\maps\GW Barrier Wall CD Memo\Fig 1 - Site Location.mxd Created By: Alex Kirk Date: 4/15/2015 Project: 0283866

ERM
Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204

Figure 1
Site Location
Groundwater Barrier Wall Conceptual Design Memorandum
Southern PEO Site
Portland, Oregon





Legend

- Geotechnical Borings

August 2012 LNAPL Thickness

- ND
- Sheen
- 0.01-0.25 ft
- 0.25 - 0.50 ft
- 0.50 - 1.0 ft
- > 1.0 ft
- Proposed Alignment of Slurry Wall
- Wall Offset for Continuous Construction
- Top of Bank
- Ordinary High Water (20.5 ft NAVD88)
- USACE 2010 LiDAR Contours (2 ft)

Notes:
LNAPL: Light Non-Aqueous Phase Liquids
ND: Not Detected
LNAPL Thickness given in feet
Aerial Imagery dated 7/7/2012

Figure 2
Groundwater Source Control Measure
Groundwater Barrier Wall
Conceptual Design Memorandum
Southern PEO Site
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM

F:\Projects\0283866_MMGL Portland PEO Site GW SCM\GIS\maps\GW Barrier Wall CD Memo\Fig 2 - Alignment and LNAPL.mxd

Created By: Alex Kirk Date: 5/1/2015 Project: 0283866

Appendix A
Boring Logs

THIS PAGE INTENTIONALLY LEFT BLANK

ERM-West, Inc.
1001 S.W. 5th Avenue, Suite 1010
Portland, Oregon 97204
Telephone: 503-488-5282

MR-1

CLIENT MMGL
PROJECT NAME PEO Portland Subsurface Investigation
PROJECT NUMBER 0283866
PROJECT LOCATION 10400 N. Burgard Way, Portland Oregon
DATE STARTED 2/16/15 **COMPLETED** 2/17/15
GROUND ELEVATION **HOLE SIZE** 3'-7/8"
CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
EQUIPMENT CME 75 Mud Rotary Drill Rig with 140 lb hammer
▽ **AT TIME OF DRILLING** 21.50 ft
LOGGED BY J. Dauphinais **CHECKED BY** K. Ewing
AT END OF DRILLING ---
NOTES Boring cleared to 5 feet below ground surface using a vacuum truck and air knife.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE IDENTIFICATION	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG (layer bottom, ft)	MATERIAL DESCRIPTION	PID (ppm)
0			ML	1.5	TOPSOIL SILT (ML): dark brown (10YR3/3), soft, moist.	
			GW	2.0	POORLY GRADED SANDY GRAVEL (GW): brown (10YR 4/3), medium dense, 15% fine grain sand, with cobbles, moist.	
			SP		POORLY GRADED SAND (SP): dark brown (10YR 3/3), loose, fine to medium grain, 5% fines, cobbles, moist.	
		5-4-5 (9)	SP		5% fines, no cobbles.	
10		5-5-7 (12)	SP			
		4-4-4 (8)	SP		black (10YR 2/1), loose, fine to medium grain, moderate hydrocarbon odor, possible staining, 5% fines, moist.	8.1
20		3-3-4 (7)	SP		no recovery 20-21.5 feet below ground surface. ▽	
		5-6-5 (11)	SP		very dark gray (10YR 3/1), loose, fine to medium grain, 5% fines, slight hydrocarbon odor, wet.	18.7
		4-4-4 (8)	SP	25.5	very dark gray (10YR 3/1), loose, fine to medium grain, 10% fines, moist.	
			SM	26.0	SILTY SAND (SM): dark brown (10YR 2/2), loose, 30% fines, moist.	
			SP		POORLY GRADED SAND (SP): dark brown (10YR 2/2), loose, 10% fines, moist.	
30		2-2-2 (4)	SP	31.0	very dark brown (10YR 3/3), loose, fine to medium grain, 10% fines, moderate hydrocarbon odor, moist.	
			ML	33.0	SILT (ML): very dark brown (10YR 3/3), soft, moderate hydrocarbon odor, 10% fine grain sand, moist.	
			CL	33.5	CLAY (CL): no visual observation based on driller indication.	
			SP	35.0	SAND (SP): no visual observation based on driller indication.	
		1-1-0 (1)	ML	36.5	CLAYEY SILT (ML): very dark gray (10YR 3/1), soft, low plastic, slight hrydrocarbon odor, moist.	
40		7-7-7 (14)	SP		POORLY GRADED SAND (SP): black (10YR 2/1), loose, fine to medium grain, slight hydrocarbon odor, trace fines, moist.	
		8-7-6 (13)	SP		moderate hydrocarbon odor.	0.7
50		8-6-7 (13)	SP	51.5	very dark gray (10YR 3.1), 5% to 10% trace fines, moist.	0.6

Bottom of borehole at 51.5 feet.

ERM-West, Inc.
1001 S.W. 5th Avenue, Suite 1010
Portland, Oregon 97204
Telephone: 503-488-5282

MR-2

CLIENT MMGL
PROJECT NAME PEO Portland Subsurface Investigation
PROJECT NUMBER 0283866
PROJECT LOCATION 10400 N. Burgard Way, Portland Oregon
DATE STARTED 2/16/15 **COMPLETED** 2/18/15
GROUND ELEVATION **HOLE SIZE** 3'-7/8"
CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
EQUIPMENT CME 75 Mud Rotary Drill Rig with 140 lb hammer
AT TIME OF DRILLING 20.00 ft
LOGGED BY J. Dauphinais **CHECKED BY** K. Ewing
AT END OF DRILLING ---
NOTES Boring cleared to 5 feet below ground surface using a vacuum truck and air knife.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE IDENTIFICATION	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	PID (ppm)
0			ML	1.5	TOPSOIL SILT (ML): dark brown (10YR3/3), soft, moist.	
			GW	2.3	POORLY GRADED SANDY GRAVEL (GW): brown (10YR 4/3), loose, 30% fine to medium grain sand, with concrete cobbles, moist.	
			SP		POORLY GRADED SAND (SP): dark brown (10YR 3/3), loose, fine to medium grain, 5% to 10% fines.	
		4-6-7 (13)			trace fines, no hydrocarbon odor, moist.	
10	MR-2-IS-10'					
		4-5-7 (12)			very dark gray (10YR 3/1), loose, fine to medium grain, moderate hydrocarbon odor, trace fines, moist.	4.3
		3-4-5 (9)			black (10YR 2/1), loose, fine to medium grain, trace fines, moderate hydrocarbon odor, wet.	909
20	MR-2-BS-20-22'				wet	
		5-3-5 (8)				33.2
30		3-4-6 (10)	ML	30.0 / 30.5	SILT (ML): very dark brown (10YR 3/3), soft, moderate hydrocarbon odor, 10% fine grain sand, wet.	0.5
			SM	31.0	SILTY SAND (SM): very dark brown (10YR 3/3), loose, moderate hydrocarbon odor, 10% fines, wet.	
			SP	31.5	POORLY GRADED SAND (SP): very dark brown (10YR 3/3), loose, moderate hydrocarbon odor, sheen on sample core water, 30% fines, wet.	
	MR-2-IS-35'		SP		POORLY GRADED SAND (SP)	
40	MR-2-BS-40-42'					
		0-4-6 (10)	SM	42.0 / 42.5	SILTY SAND (SM): dark grayish brown (10YR 4/2), very loose, 30% fine sand, wet.	
			SP		POORLY GRADED SAND (SP)	
		7-9-8 (17)			POORLY GRADED SAND (SP): very dark gray (10YR 3/1), loose, fine to medium grain, moderate hydrocarbon odor, sheen on sample core water, 5% fines, wet.	
50		8-6-7 (13)		51.5		

Bottom of borehole at 51.5 feet.

ERM-West, Inc.
1001 S.W. 5th Avenue, Suite 1010
Portland, Oregon 97204
Telephone: 503-488-5282

MR-3

CLIENT MMGL
PROJECT NAME PEO Portland Subsurface Investigation
PROJECT NUMBER 0283866
PROJECT LOCATION 10400 N. Burgard Way, Portland Oregon
DATE STARTED 2/16/15 **COMPLETED** 2/18/15
GROUND ELEVATION **HOLE SIZE** 3'-7/8"
CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
EQUIPMENT CME 75 Mud Rotary Drill Rig with 140 lb hammer
AT TIME OF DRILLING 20.00 ft
LOGGED BY J. Dauphinais **CHECKED BY** K. Ewing
AT END OF DRILLING ---
NOTES Boring cleared to 5 feet below ground surface using a vacuum truck and air knife.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE IDENTIFICATION	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	PID (ppm)
0			ML	0.8	TOPSOIL SILT (ML): dark brown (10YR3/3), soft, moist.	
			GW	2.5	POORLY GRADED SANDY GRAVEL (GW): dark brown (10YR 3/3), loose, 30% fine to medium grain sand, with cobbles, moist.	
			SP		POORLY GRADED SAND (SP): dark brown (10YR 3/3), loose, fine to medium grain, 10% fines, cobbles (3- to 5-inch diameter).	
	MR-3-BS-8-10'				dark yellow brown (10YR 3/4), loose, trace fines.	
10		4-4-4 (8)			dark brown (10YR 3/3), trace gravel.	
		4-4-5 (9)			dark yellow brown (10YR 3/4), 5% fines, moist to wet. very dark gray (10YR 3/1), moderate hydrocarbon odor, sheen on sample core water, wet.	280
20	MR-3-IS-18-20'	2-4-4 (8)			∇ black (10YR 2/1), 10% fines, moderate hydrocarbon odor, sheen on sample core water, wet.	188
		3-3-5 (8)		26.0	very dark gray (10YR 3/1), slight hydrocarbon odor.	6.3
			SM	26.5	SILTY SAND (SM)	
			SP	30.0	POORLY GRADED SAND (SP)	
30		1-3-5 (8)	SM	30.5	SILTY SAND (SM): very dark gray (10YR 3/1), very loose, fine grain sand, 30% fines, wet.	
			ML	31.0	SILT (ML): dark brown (10YR 3/3), soft, low plastic, 20% clay, trace fine sand, wet.	6.1
	MR-3-BS-33-35'		SP	34.0	POORLY GRADED SAND (SP): very dark gray (10YR 3/1), loose, 10% fines, slight hydrocarbon odor, wet. black (10YR 2/1), loose, fine to medium grain, 10% fines, slight hydrocarbon odor, wet.	
		0-1-2 (3)	ML	35.0	CLAYEY SILT (ML): dark brown (10YR 3/3), soft, trace fine sand, moist.	7.7
					POORLY GRADED SAND (SP): very dark grayish brown (10YR 3/2), very loose, fine to medium grain, 10% fines, slight hydrocarbon odor, wet.	
40		9-7-8 (15)			very dark gray (10YR 3/1), 5% fines, slight hydrocarbon odor, sheen, wet.	2.4
	MR-3-IS-42'		SM	42.5	SILTY SAND (SM): dark grayish brown (10YR 4/2), very loose, 30% fine sand, wet.	
		8-6-6 (12)	SP		black (10YR 2/1), loose, fine to medium grain, trace fines, slight hydrocarbon odor, slight sheen, moist.	0.8
50		6-5-6 (11)		51.5		2.4

Bottom of borehole at 51.5 feet.

ERM-West, Inc.
1001 S.W. 5th Avenue, Suite 1010
Portland, Oregon 97204
Telephone: 503-488-5282

MR-4

CLIENT MMGL
PROJECT NAME PEO Portland Subsurface Investigation
PROJECT NUMBER 0283866
PROJECT LOCATION 10400 N. Burgard Way, Portland Oregon
DATE STARTED 2/16/15 **COMPLETED** 2/19/15
GROUND ELEVATION **HOLE SIZE** 3'-7/8"
CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
EQUIPMENT CME 75 Mud Rotary Drill Rig with 140 lb hammer
▽ **AT TIME OF DRILLING** 20.00 ft
LOGGED BY J. Dauphinais **CHECKED BY** K. Ewing
AT END OF DRILLING ---
NOTES Boring cleared to 5 feet below ground surface using a vacuum truck and air knife.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE IDENTIFICATION	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	PID (ppm)
0			ML	1.0	TOPSOIL SILT (ML): dark brown (10YR3/3)	
			GW	2.5	POORLY GRADED SANDY GRAVEL (GW): dark brown (10YR 3/3), loose, moist.	
			SP		POORLY GRADED SAND (SP): dark brown (10YR 3/3), loose, fine to medium grain, 10% fines, no hydrocarbon odor.	
		2-2-4 (6)			5% fines, moist.	
10		5-5-4 (9)				
		4-4-5 (9)			black (10YR 2/1), loose, fine grain, 20% fines, moderate hydrocarbon odor, sheen on water, wet.	108
20				20.0 ▽		
		2-4-5 (9)	SM	21.5	SILTY SAND (SM): very dark gray (10YR 3/1), loose, 20% fines, moderate hydrocarbon odor, sheen on sample core water, wet.	192
		5-4-6 (10)	SP		POORLY GRADED SAND (SP): black (10YR 2/1), loose, fine to medium grain, 10% fines, moderate hydrocarbon odor, sheen on water, wet.	26.9
30		5-4-4 (8)		34.0	very dark gray (10YR 3/1), slight hydrocarbon odor, sheen on water, wet.	27.6
	MR-4-IS-34'		ML	36.0	CLAYEY SILT (ML)	
	MR-4-BS-36-38'		SP		POORLY GRADED SAND (SP): very dark gray (10YR 3/3), loose, fine to medium grain, trace fines, slight hydrocarbon odor, no sheen, moist.	
40		6-4-3 (7)			10% fines.	5.1
		6-4-6 (10)				6.2
50	MR-4-BS-48-50'					
	MR-4-IS-50'			52.0		

Bottom of borehole at 52.0 feet.

ERM-West, Inc.
1001 S.W. 5th Avenue, Suite 1010
Portland, Oregon 97204
Telephone: 503-488-5282

MR-5

CLIENT MMGL
PROJECT NAME PEO Portland Subsurface Investigation
PROJECT NUMBER 0283866
PROJECT LOCATION 10400 N. Burgard Way, Portland Oregon
DATE STARTED 2/16/15 **COMPLETED** 2/20/15
GROUND ELEVATION **HOLE SIZE** 3'-7/8"
CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
EQUIPMENT CME 75 Mud Rotary Drill Rig with 140 lb hammer
AT TIME OF DRILLING 20.00 ft
LOGGED BY J. Dauphinais **CHECKED BY** K. Ewing
AT END OF DRILLING ---
NOTES Boring cleared to 7.5 feet below ground surface using a vacuum truck and air knife.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE IDENTIFICATION	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	PID (ppm)
0				0.4	ASPHALT 5 inches thick	
			GW	1.5	WELL GRADED SANDY GRAVEL (GW): dark brown (10YR 3/3), loose, fine to medium grain, no hydrocarbon odor, 30% sand, cobbles (5- inches to 1.5- feet in diameter) dry.	
			SP		POORLY GRADED SAND (SP): dark brown (10YR 3/3), loose, fine to medium grain, 10% fines, no hydrocarbon odor, moist.	
		1-1-2 (3)				
10		2-3-3 (6)			5% to 10% fines,	0.2
					very dark gray (10YR 3/1), 5% fines, wet.	192
20		6-4-5 (9)			▽ 10% fines, slight hydrocarbon odor, sheen on water, wet.	2.6
	MR-5-BS-28-30'				moist.	
30						
	MR-5-IS-31'					
	MR-5-IS-33'			35.0		
	MR-5-BS-35-37'		ML	37.0	CLAYEY SILT (ML): dark gray (10YR 4/1), soft, low plastic, trace fine sand, slight hydrocarbon odor, moist.	
40		7-8-5 (13)	SP		POORLY GRADED SAND (SP): very dark gray (10YR 3/1), loose, fine to medium grain, 10% fines, slight hydrocarbon odor, sheen on water, wet.	5.2
		7-7-7 (14)			no sheen.	
50		6-6-4 (10)		51.5	20% fines.	4.2

Bottom of borehole at 51.5 feet.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix B
Laboratory Test Results

THIS PAGE INTENTIONALLY LEFT BLANK

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

March 9, 2015
15LS3165.01

ERM, Inc.
1001 SW 5th Ave
Suite 1010
Portland, OR 97204

Attn: Kathryn Ewing

RE: GEOTECHNICAL TEST RESULTS
MMGL PEO PORTLAND
PROJECT ID: 0283866

Dear Ms. Ewing:

Submitted herein are the results of Moisture Content, Sieve, Hydrometer, Atterberg Limits, Classification, Direct Shear and Tube Density performed on eight (8) bag samples and eight (8) Shelby Tubes from the above referenced project. All testing was performed per ASTM Standards while subject to JLT's internal QA/QC and data validation procedures.

We appreciate the opportunity to provide our services and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

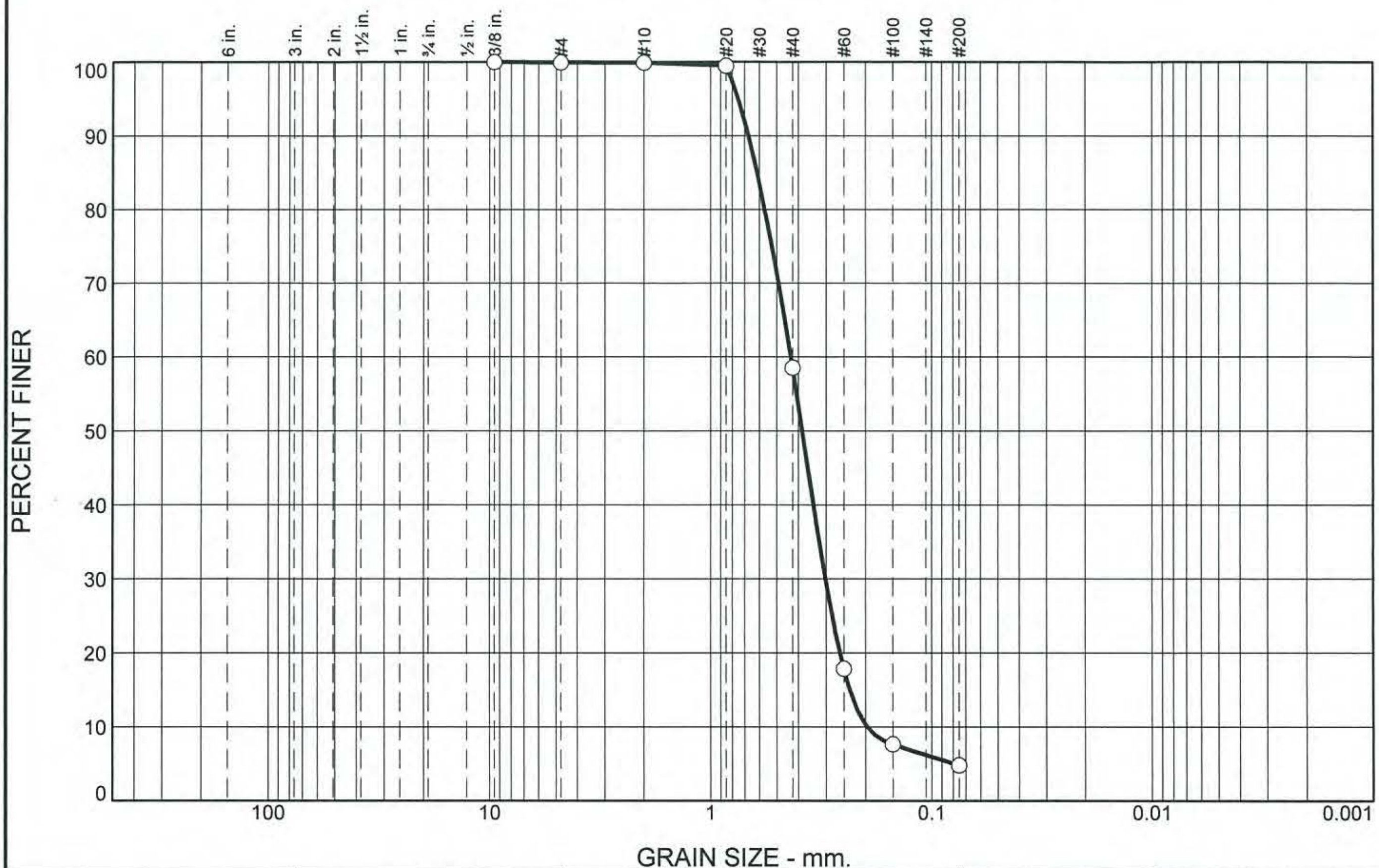
JLT LABORATORIES, INC.

John Boschuk, Jr., P.E., C.F.E.
President

cc: GrafCon - INVOICE - PDF Only

Enclosures
JB/mlb
\wp10\letter\1546
Inv# 5894

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.0	41.3	53.8	4.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.9		
#10	99.9		
#20	99.5		
#40	58.6		
#60	17.9		
#100	7.7		
#200	4.8		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6707 D_{85}= 0.6128 D_{60}= 0.4325
D_{50}= 0.3844 D_{30}= 0.3021 D_{15}= 0.2344
D_{10}= 0.1951 C_u= 2.22 C_c= 1.08

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 26.35%

Location: 0283866
Sample Number: MR-2-BS **Depth:** 20-22 ft **Date:** 03/06/2015

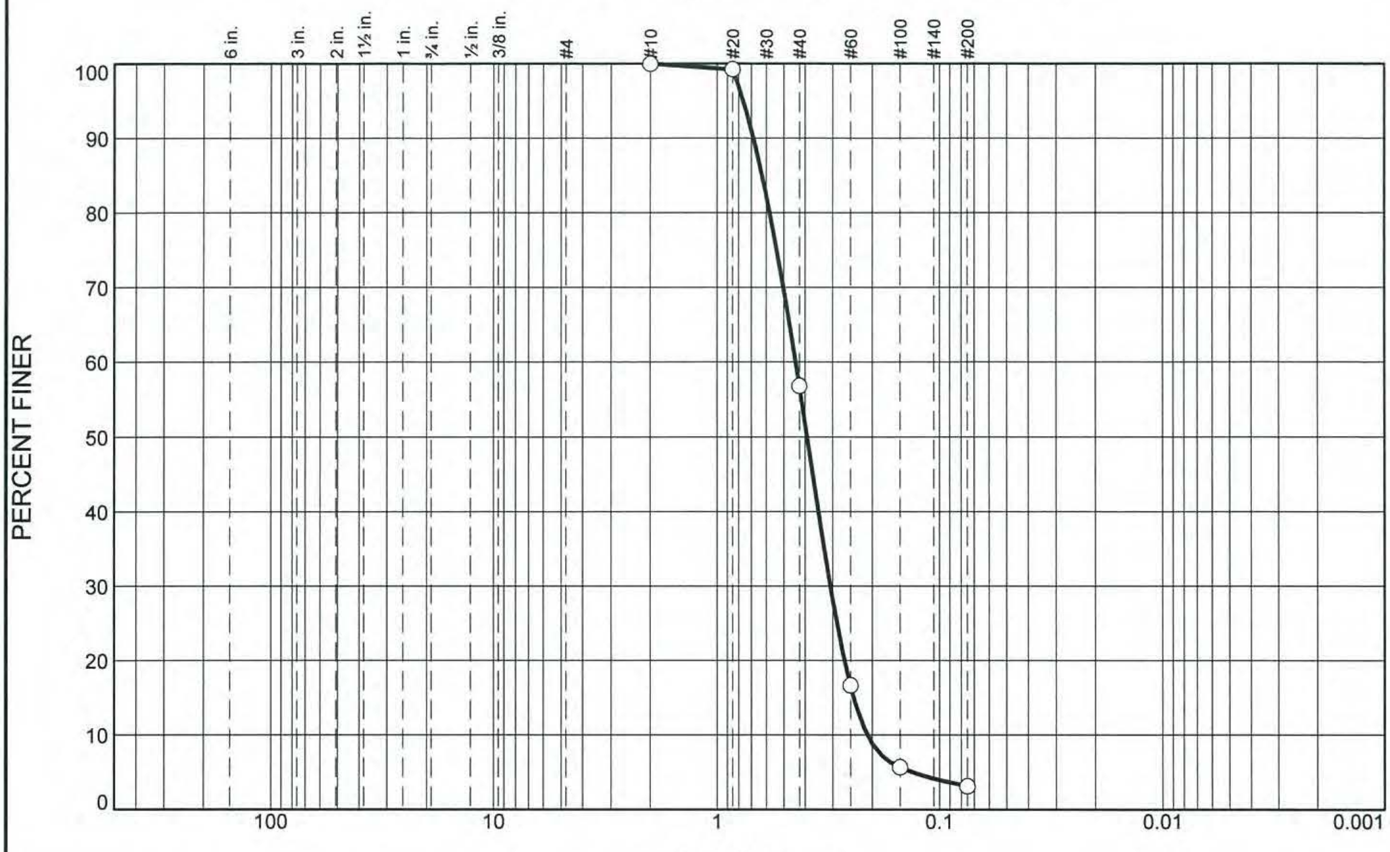
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	43.2	53.6	3.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.2		
#40	56.8		
#60	16.7		
#100	5.7		
#200	3.2		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.6840 D_{85}= 0.6260 D_{60}= 0.4416
D_{50}= 0.3918 D_{30}= 0.3074 D_{15}= 0.2414
D_{10}= 0.2089 C_u= 2.11 C_c= 1.02

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 14.10%
Hydrometer is Not Applicable

Location: 0283866
Sample Number: MR-3-BS **Depth:** 8-10 ft **Date:** 03/06/2015

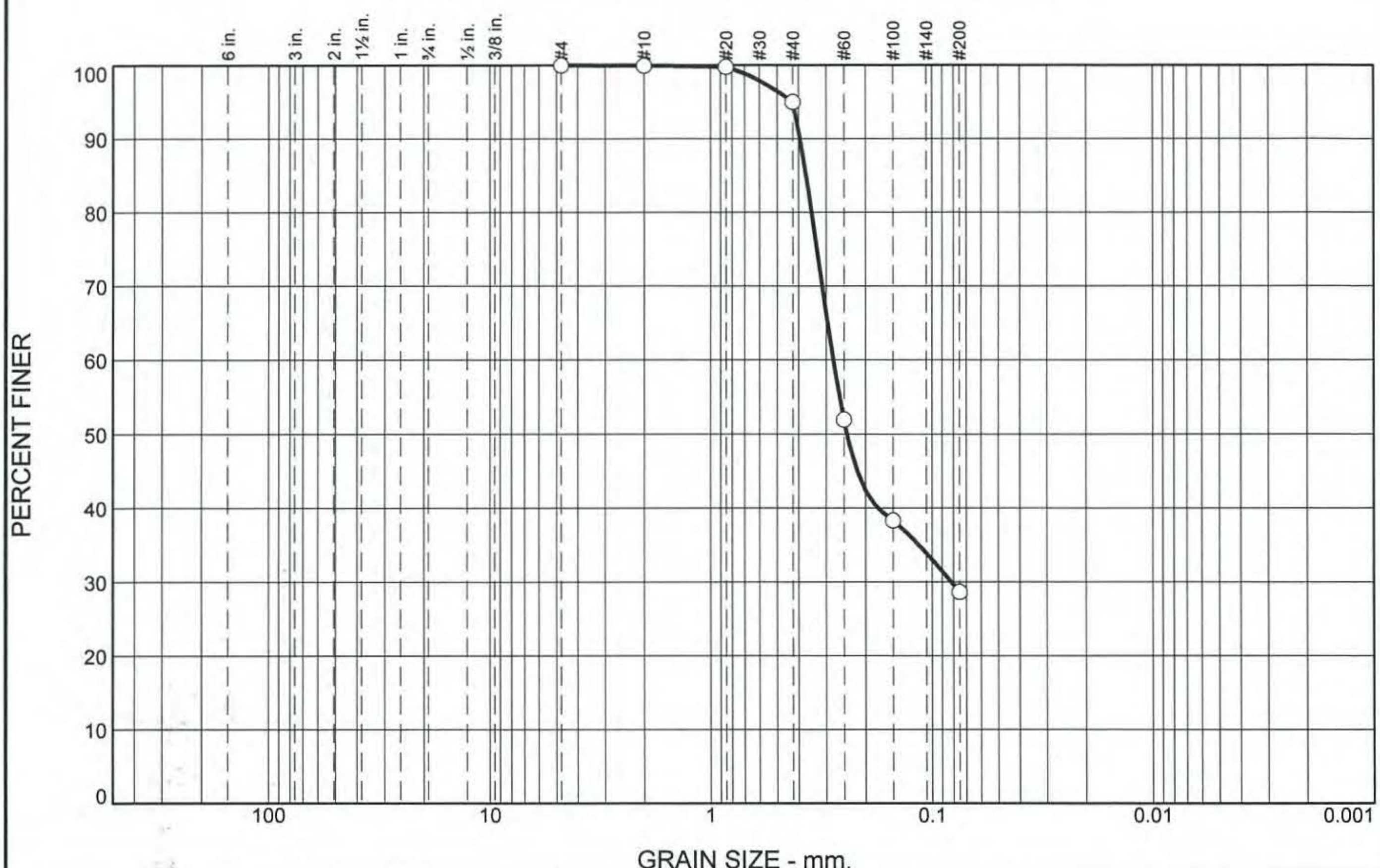
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	4.9	66.3	28.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	95.0		
#60	52.0		
#100	38.3		
#200	28.7		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3942 D_{85}= 0.3699 D_{60}= 0.2788
D_{50}= 0.2419 D_{30}= 0.0817 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

As-Rec'd M/C = 33.20%

Location: 0283866
Sample Number: MR-5-BS **Depth:** 28-30 ft **Date:** 03/06/2015

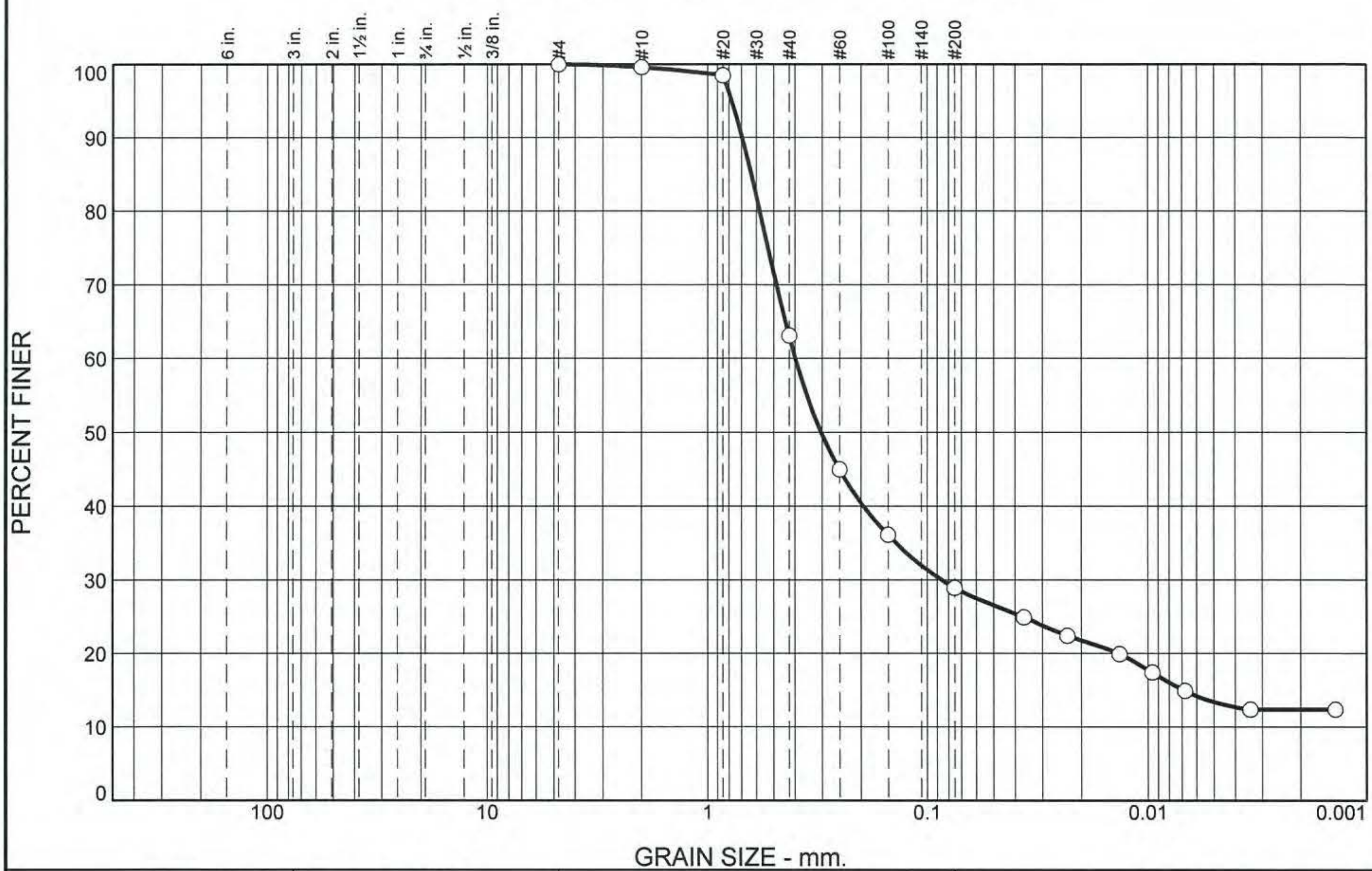
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	36.5	34.2	15.5	13.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.6		
#20	98.5		
#40	63.1		
#60	45.0		
#100	36.1		
#200	28.9		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6934 D_{85}= 0.6307 D_{60}= 0.3976
D_{50}= 0.3027 D_{30}= 0.0859 D_{15}= 0.0069
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

As-Rec'd M/C = 37.66%

Location: 0283866
Sample Number: MR-3-BS **Depth:** 33-35 ft **Date:** 03/06/2015

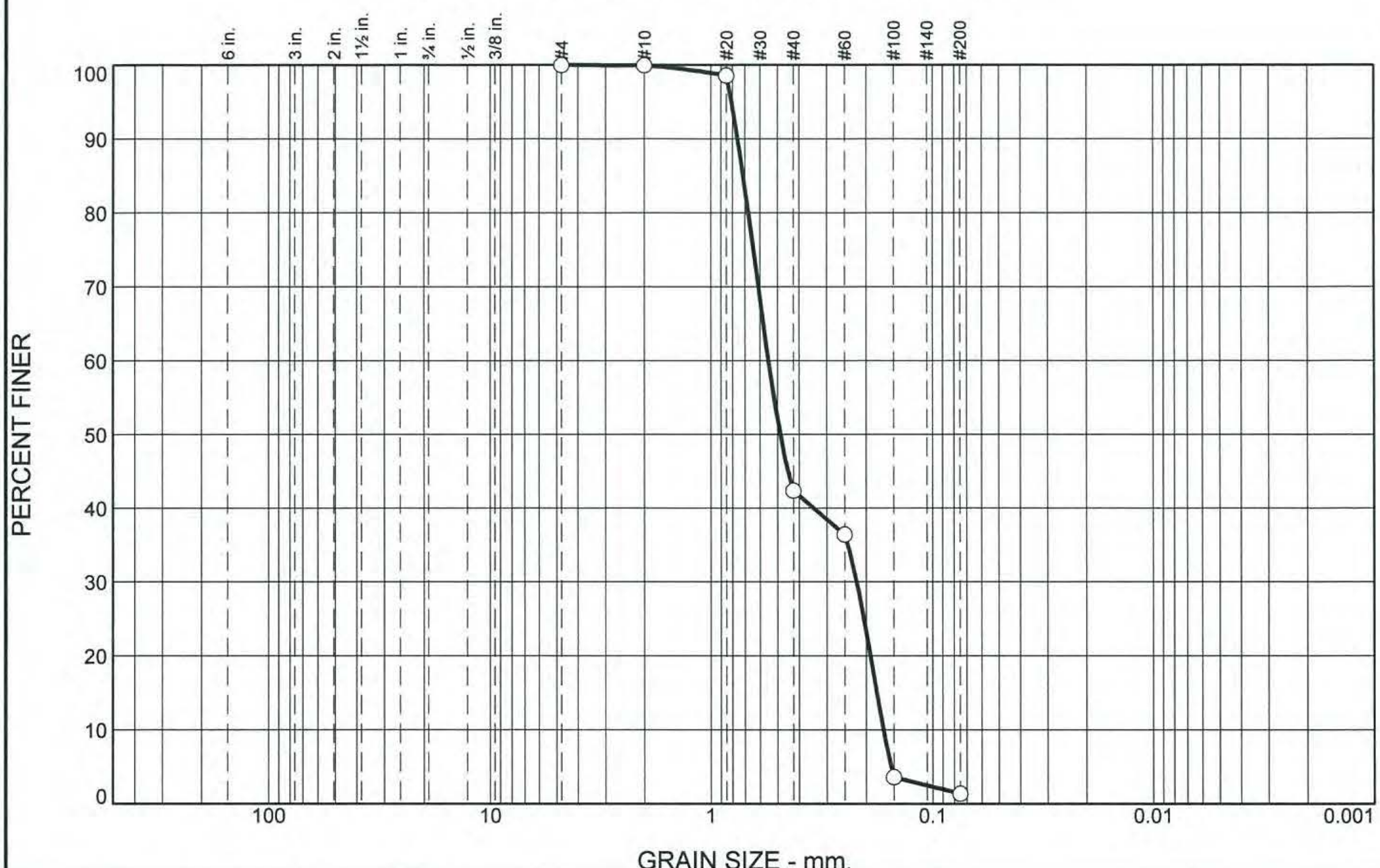
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	57.6	41.0	1.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	98.6		
#40	42.4		
#60	36.4		
#100	3.6		
#200	1.4		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.7560 D_{85}= 0.7139 D_{60}= 0.5487
D_{50}= 0.4860 D_{30}= 0.2198 D_{15}= 0.1784
D_{10}= 0.1665 C_u= 3.30 C_c= 0.53

Classification

USCS= SP AASHTO=

Remarks

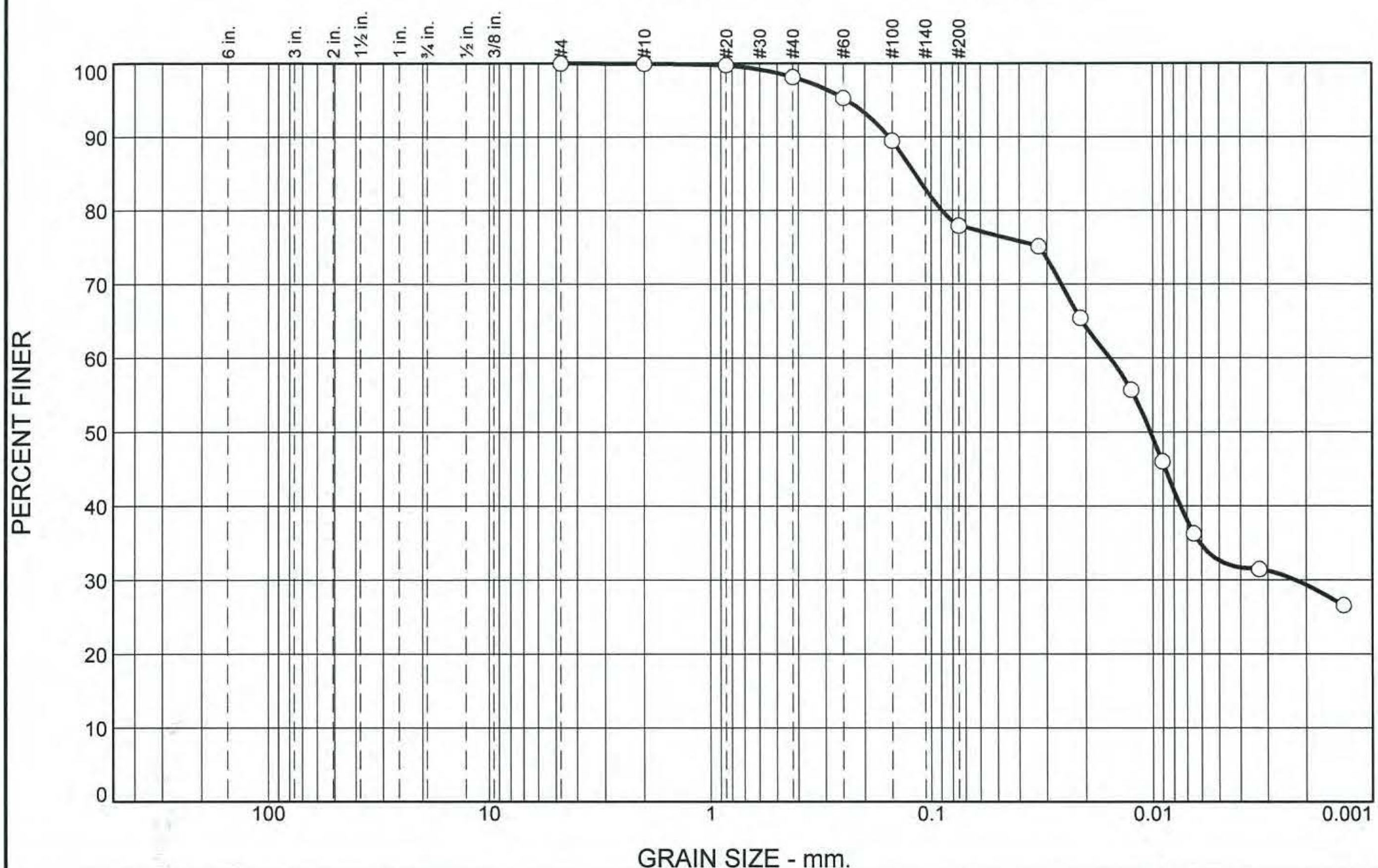
As-Rec'd M/C = 24.11%
Hydrometer is Not Applicable

Location: 0283866
Sample Number: MR-4-BS **Depth:** 36-38 ft **Date:** 03/06/2015

JLT Laboratories, Inc. Canonsburg, PA	**Client:** ERM **Project:** MMGL PEO Portland ERM Project No: 0283866 **Project No:** 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.8	20.1	45.4	32.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	98.1		
#60	95.3		
#100	89.5		
#200	78.0		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.1548 D_{85}= 0.1178 D_{60}= 0.0155
D_{50}= 0.0102 D_{30}= 0.0022 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

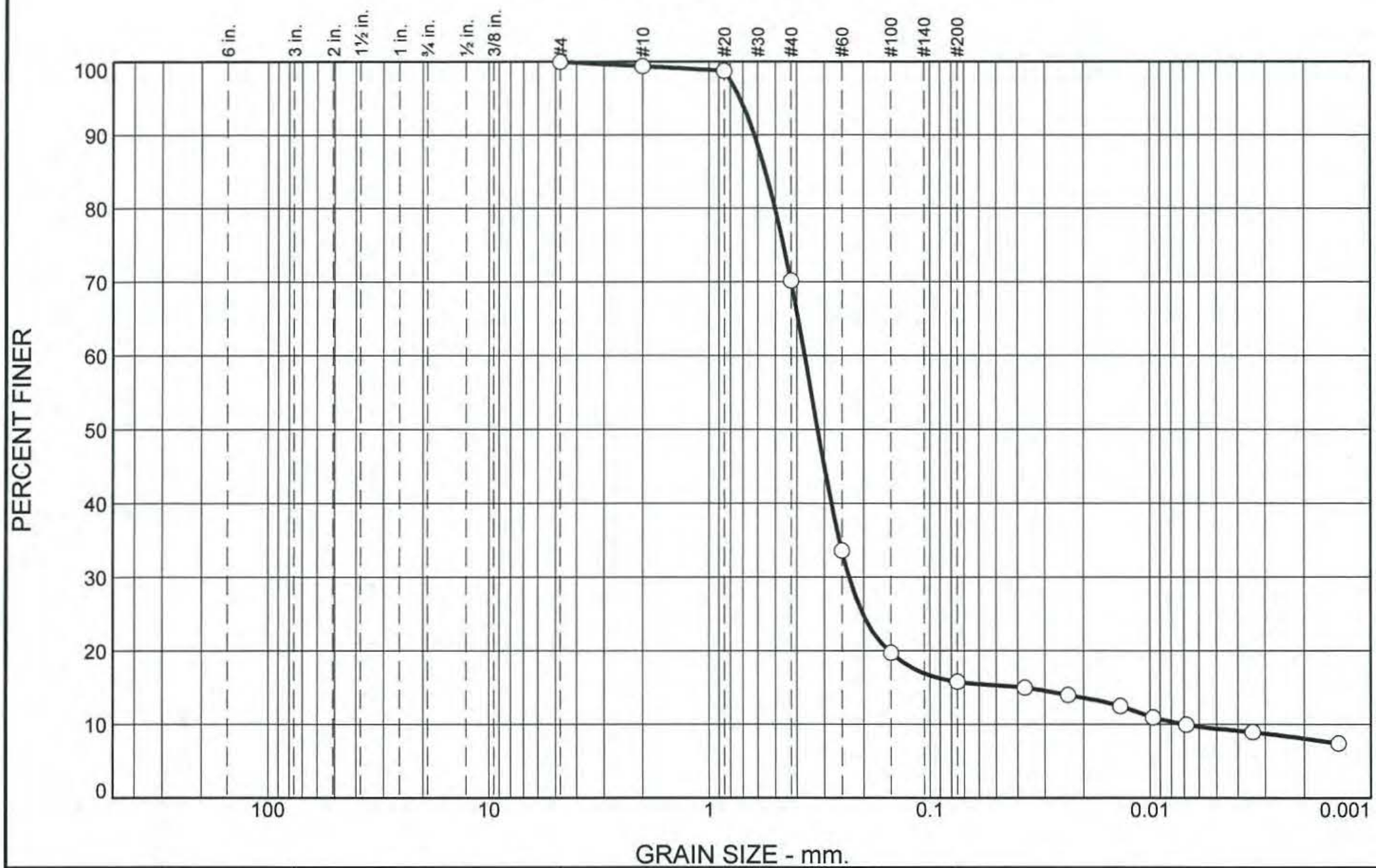
As-Rec'd M/C = 46.62%

Location: 0283866
Sample Number: MR-5-BS **Depth:** 35-37 ft **Date:** 03/06/2015

JLT Laboratories, Inc. Canonsburg, PA	**Client:** ERM **Project:** MMGL PEO Portland ERM Project No: 0283866 **Project No:** 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	29.2	54.4	6.4	9.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.4		
#20	98.8		
#40	70.2		
#60	33.6		
#100	19.8		
#200	15.8		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.6197 D_{85}= 0.5515 D_{60}= 0.3684
D_{50}= 0.3219 D_{30}= 0.2314 D_{15}= 0.0370
D_{10}= 0.0070 C_u= 52.85 C_c= 20.86

Classification

USCS= SM AASHTO=

Remarks

As-Rec'd M/C = 30.97%

Location: 0283866
Sample Number: MR-2-BS **Depth:** 40-42 ft **Date:** 03/06/2015

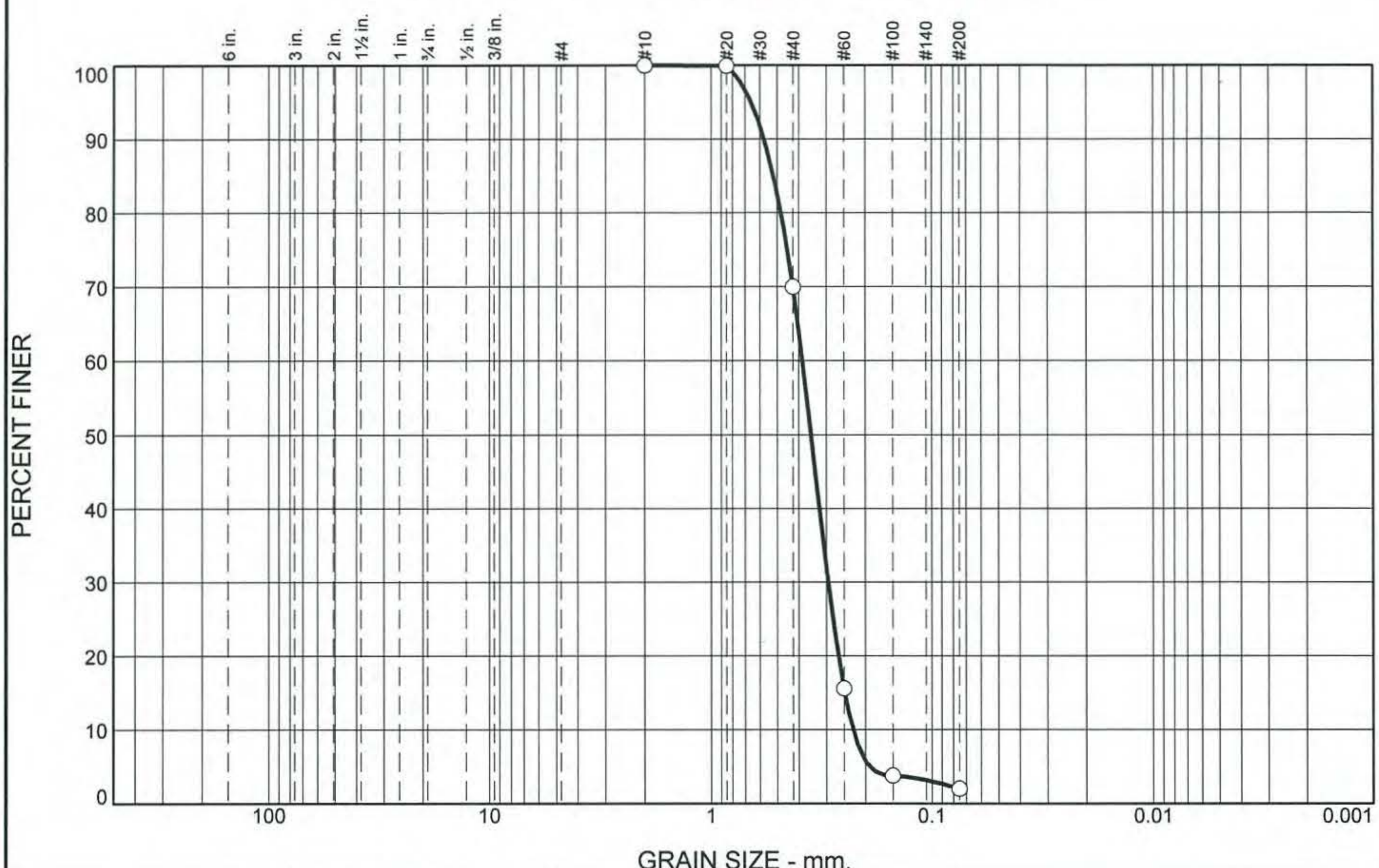
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	30.0	68.0	2.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	70.0		
#60	15.6		
#100	3.8		
#200	2.0		

* (no specification provided)

Material Description

Bag Sample

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5724 D_{85}= 0.5193 D_{60}= 0.3849
D_{50}= 0.3518 D_{30}= 0.2939 D_{15}= 0.2478
D_{10}= 0.2267 C_u= 1.70 C_c= 0.99

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 28.16%

Location: 0283866
Sample Number: MR-4-BS **Depth:** 48-50 ft **Date:** 03/06/2015

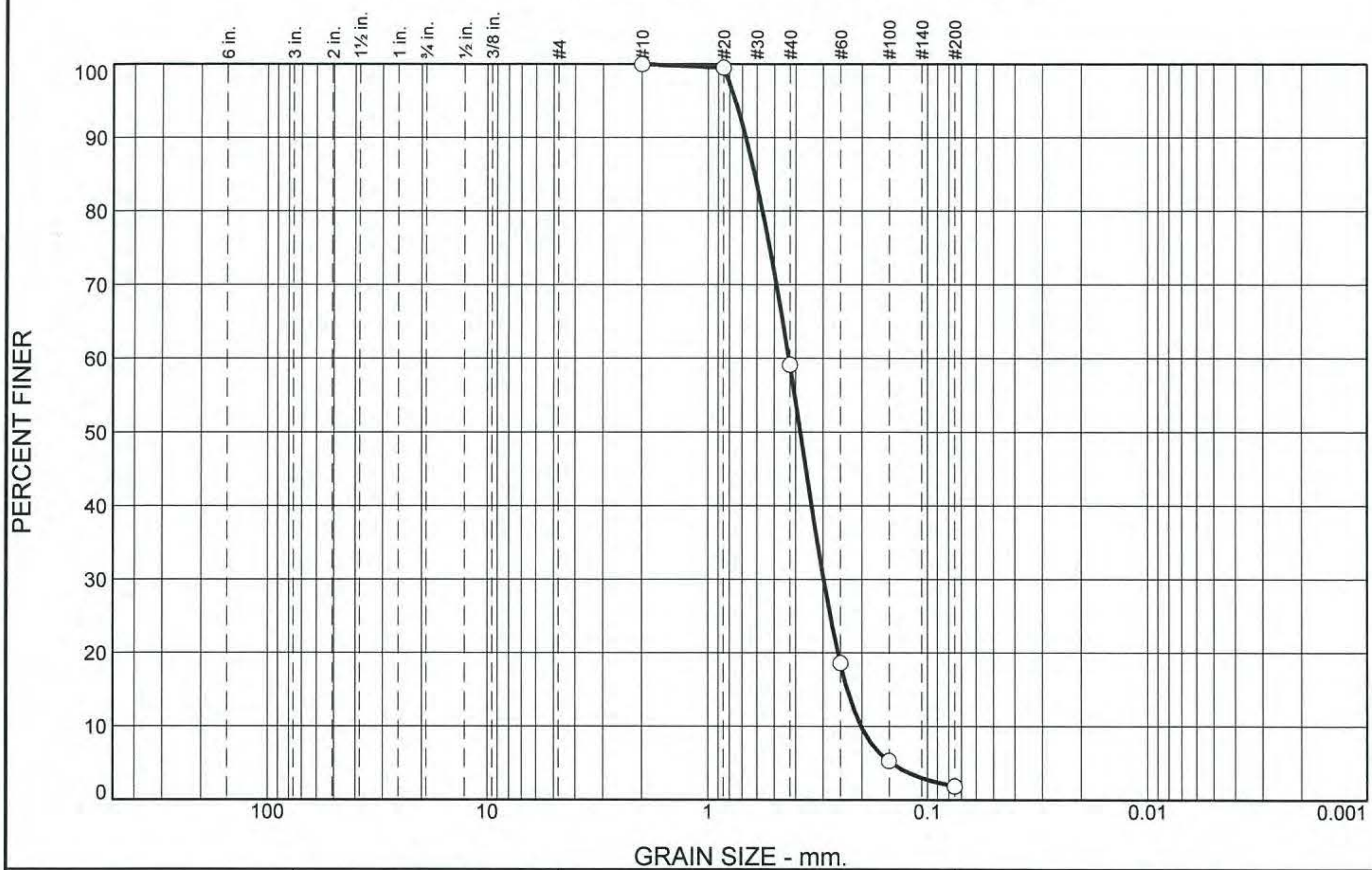
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	40.9	57.2	1.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.5		
#40	59.1		
#60	18.6		
#100	5.3		
#200	1.9		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6718 D_{85}= 0.6131 D_{60}= 0.4295
D_{50}= 0.3807 D_{30}= 0.2978 D_{15}= 0.2320
D_{10}= 0.2005 C_u= 2.14 C_c= 1.03

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 24.43%
Hydrometer is Not Applicable

Location: 0283866
Sample Number: MR-2-IS **Depth:** 10 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

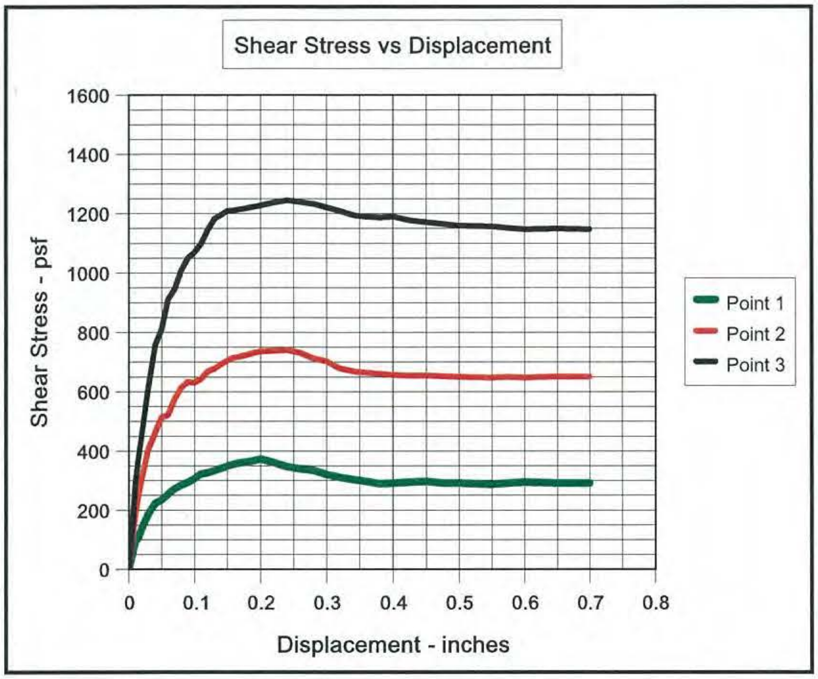
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

DIRECT SHEAR TEST RESULTS
ASTM D-3080 2.8-inch GeoTest Shear Box

JLT

Client:	ERM	Print Date:	03/04/2015
Project:	"0283866 MMGL PEO Portland	Project No.:	15LS3165.01
Material:	Black fine grained material	Perf'd By:	MS
Sample ID:	MR-2-IS-10 ft	Chk'd By:	JBJr



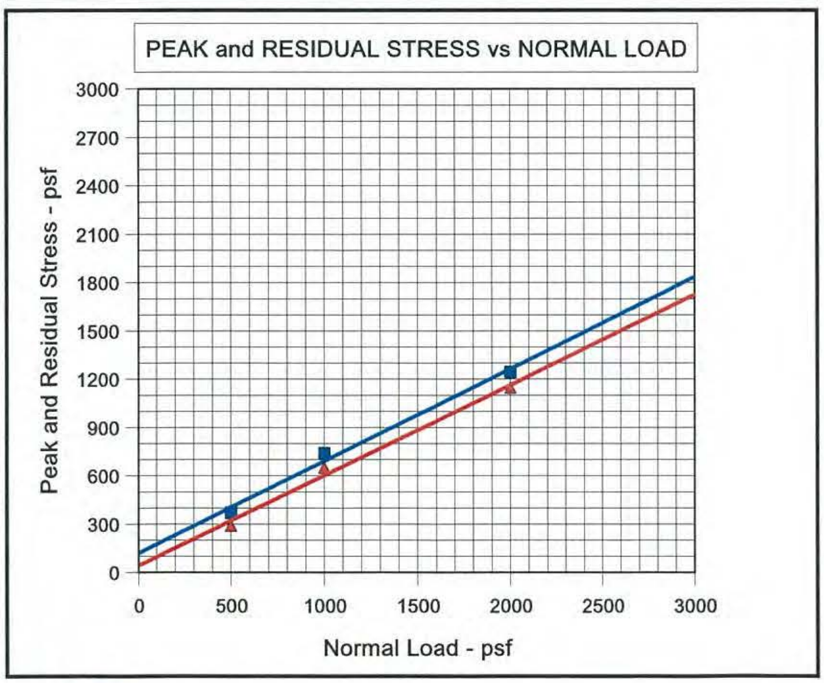
PHYSICAL PROPERTIES

Initial	Point 1	Point 2	Point 3
Moisture Cnt, %	18.48	19.23	15.18
Dry Density, pcf	81.3	78.1	80.2
Saturation , %	47.40	45.65	37.86
Void Ratio	1.0330	1.1166	1.0624

At Test	Point 1	Point 2	Point 3
Moisture Cnt, %	35.20	37.60	37.70
Dry Density, pcf	83.0	80.4	82.7
Saturation , %	49.34	48.21	40.28
Void Ratio	0.9923	1.0573	0.9984

Other Information:

Specified Soil Properties	Density	Moisture
Tube Sample	pcf	%



CURVE DATA

	Normal Load	Peak Strength	Residual Strength
Point	psf	psf	psf
1	500	371	291
2	1000	740	650
3	2000	1244	1147
4			
5			
6			

Displacement Rate: 0.04 in/min

Saturation: No

STRENGTH PROPERTIES

		Peak	Residual
Cohesion	psf	119	43
Friction	Degrees	29.7	29.2

Comments:

Soil above the GWT.

JLT *Laboratories, Inc.*

FIGURE- MR-2 IS- 10 ft

INPUT DATA FOR

ERM
"0283866
Black fine grained material

MR-2-IS-10 ft

Print Date: 03/04/2015
Project No.:15LS3165.01
Perf'd By: MS

Chk'd By: JBJr

UPPER GRAPH

Displacement inches	Point 1 Load lbs	Point 2 Load lbs	Point 3 Load lbs	Point 1 Stress psf	Point 2 Stress psf	Point 3 Stress psf
0.000	0.0	0.0	0.0	0.0	0.0	0.0
0.005	2.0	4.1	5.3	47.3	97.0	125.4
0.010	3.9	7.8	12.2	92.3	184.5	288.6
0.015	4.5	10.6	16.0	106.4	250.7	378.5
0.020	5.9	12.9	19.4	139.6	305.1	458.9
0.030	7.9	17.1	26.0	186.9	404.5	615.0
0.040	9.4	19.4	31.9	222.3	458.9	754.6
0.050	9.9	21.7	34.3	234.2	513.3	811.3
0.060	10.7	22.0	38.5	253.1	520.4	910.7
0.070	11.5	24.3	40.0	272.0	574.8	946.2
0.080	12.0	25.9	42.6	283.8	612.6	1007.7
0.090	12.4	26.8	44.4	293.3	633.9	1050.2
0.100	12.9	26.7	45.2	305.1	631.6	1069.2
0.110	13.6	27.2	46.4	321.7	643.4	1097.5
0.120	13.8	28.3	48.4	326.4	669.4	1144.9
0.130	14.1	28.7	50.0	333.5	678.9	1182.7
0.140	14.4	29.3	50.5	340.6	693.1	1194.5
0.150	14.7	29.8	51.1	347.7	704.9	1208.7
0.160	15.0	30.2	51.2	354.8	714.4	1211.1
0.170	15.2	30.4	51.4	359.5	719.1	1215.8
0.180	15.3	30.6	51.5	361.9	723.8	1218.2
0.190	15.5	30.9	51.7	366.6	730.9	1222.9
0.200	15.7	31.1	51.9	371.4	735.6	1227.6
0.220	15.2	31.2	52.3	359.5	738.0	1237.1
0.240	14.6	31.3	52.6	345.3	740.4	1244.2
0.260	14.3	30.9	52.4	338.3	730.9	1239.5
0.280	14.1	30.1	52.1	333.5	712.0	1232.4
0.300	13.5	29.7	51.6	319.3	702.5	1220.5
0.320	13.1	28.7	51.1	309.9	678.9	1208.7
0.340	12.8	28.3	50.5	302.8	669.4	1194.5
0.360	12.5	28.1	50.3	295.7	664.7	1189.8
0.380	12.2	27.9	50.2	288.6	659.9	1187.4
0.400	12.3	27.8	50.3	290.9	657.6	1189.8
0.425	12.4	27.7	49.8	293.3	655.2	1178.0
0.450	12.5	27.7	49.5	295.7	655.2	1170.9
0.475	12.3	27.6	49.3	290.9	652.9	1166.1
0.500	12.3	27.5	49.0	290.9	650.5	1159.0
0.550	12.1	27.4	48.9	286.2	648.1	1156.7
0.057	12.3	27.5	48.7	290.9	650.5	1152.0
0.600	12.4	27.4	48.5	293.3	648.1	1147.2
0.650	12.3	27.5	48.6	290.9	650.5	1149.6
0.700	12.3	27.5	48.5	290.9	650.5	1147.2
0.750	12.3	27.5	48.5	290.9	650.5	1147.2

LOWER GRAPH

Pn	Peak	Residual
500	371.4	290.9
1000	740.4	650.5
2000	1244.2	1147.2

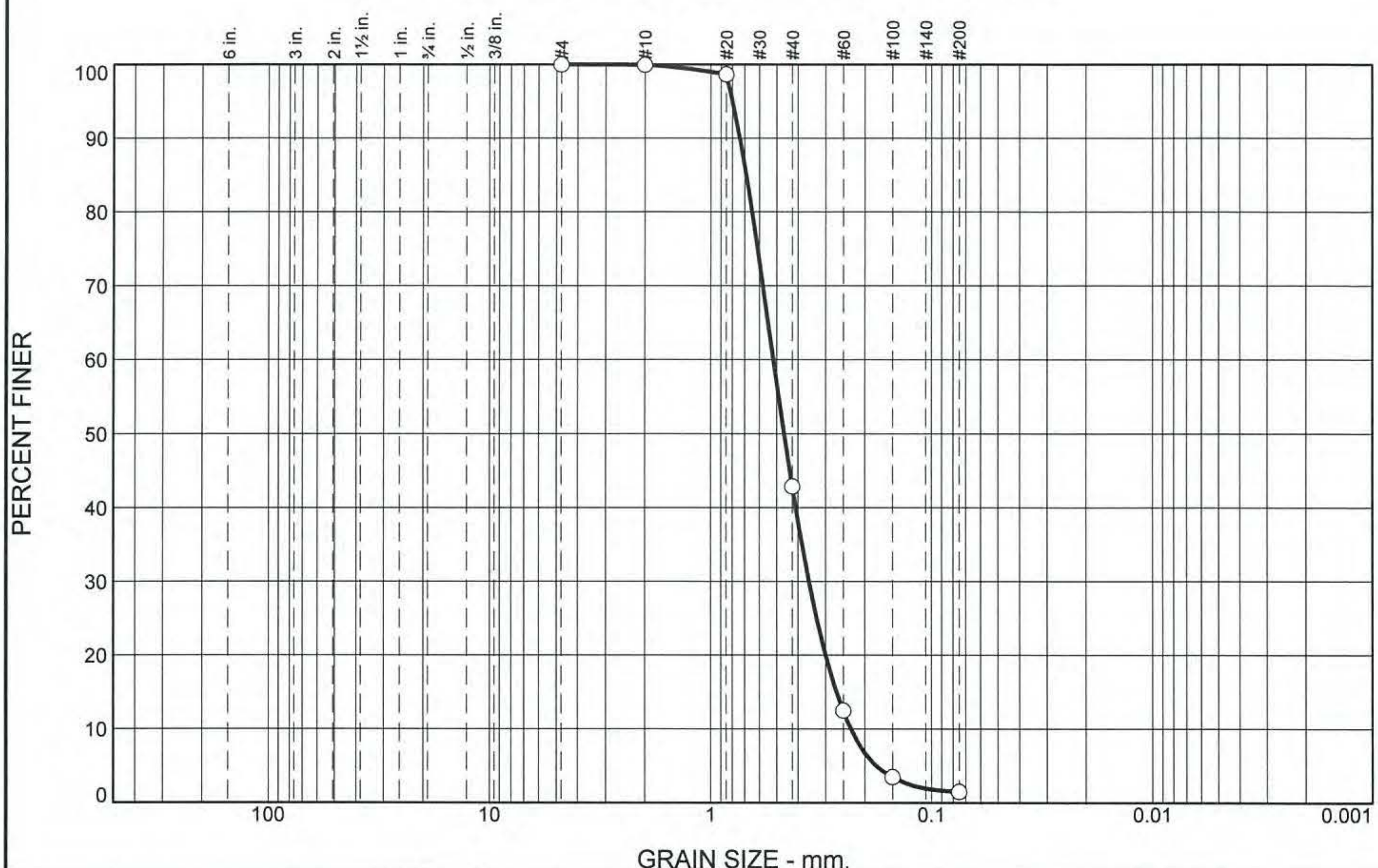
Engineering Properties

	Peak	Residual
Slope, m	0.571	0.56
Cohesion	119	42.6
Phi, degrees	29.73	29.25

FIGURE- MR-2 IS- 10 ft

Laboratories, Inc.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	57.1	41.4	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	98.7		
#40	42.9		
#60	12.5		
#100	3.5		
#200	1.5		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.7359 D_{85}= 0.6883 D_{60}= 0.5172
D_{50}= 0.4626 D_{30}= 0.3564 D_{15}= 0.2676
D_{10}= 0.2304 C_u= 2.24 C_c= 1.07

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 27.39%
Hydrometer is Not Applicable

Location: 0283866
Sample Number: MR-3-IS **Depth:** 18 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

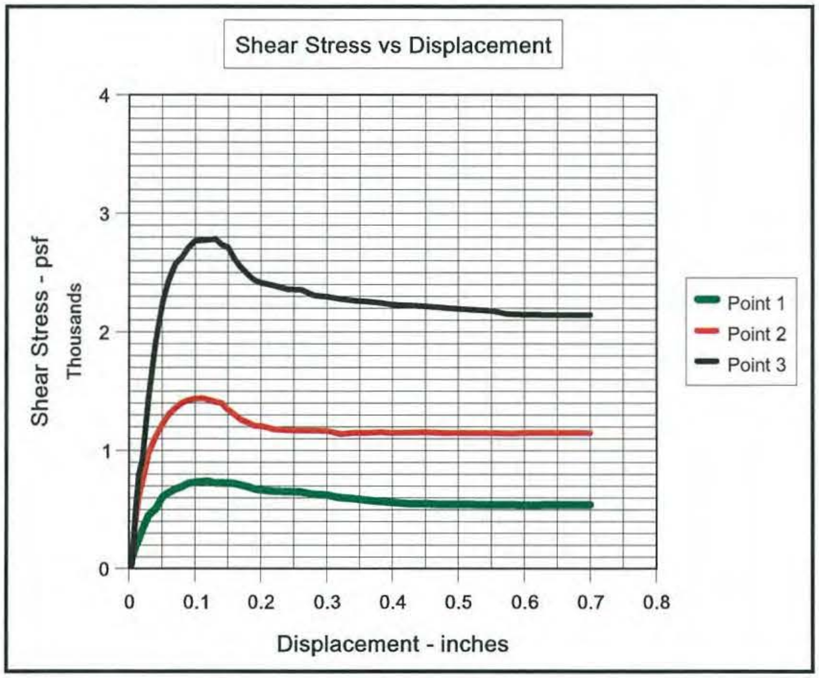
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

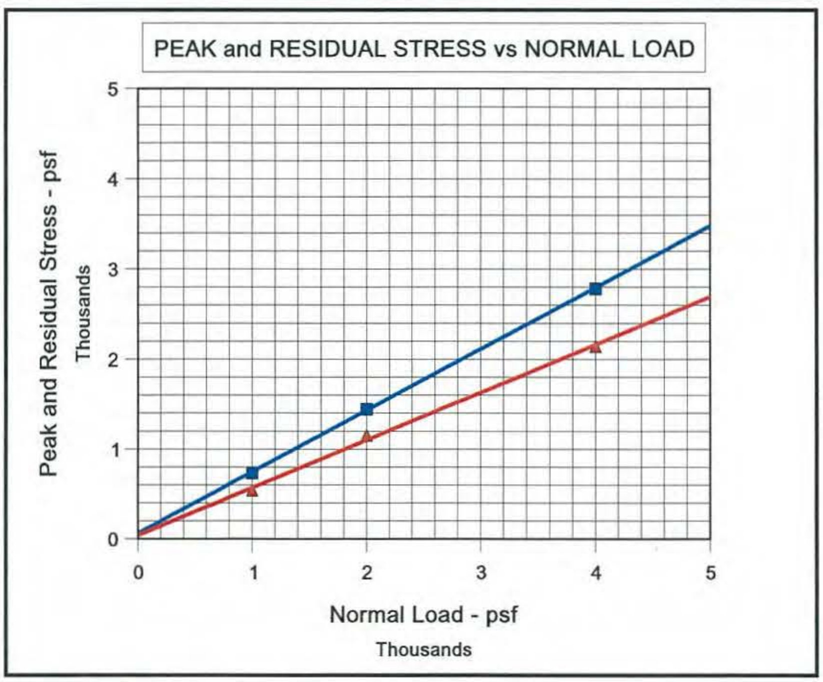
Tested By: RL **Checked By:** JB

DIRECT SHEAR TEST RESULTS

ASTM D-3080 2.8-inch GeoTest Shear Box

Client:	ERM	Print Date:	03/04/2015
Project:	"0283866 MMGL PEO Portland	Project No.:	15LS3165.01
Material:	Black fine grained material	Perf'd By:	MS
Sample ID:	MR-3-IS-18 ft	Chk'd By:	JBJr





PHYSICAL PROPERTIES

Initial	Point 1	Point 2	Point 3
Moisture Cnt, %	24.50	23.52	24.47
Dry Density, pcf	90.8	92.1	92.3
Saturation , %	79.1	78.3	82.0
Void Ratio	0.8209	0.7958	0.7911

At Test	Point 1	Point 2	Point 3
Moisture Cnt, %	35.20	37.60	37.70
Dry Density, pcf	93.1	95.5	96.5
Saturation , %	83.7	85.2	90.8
Void Ratio	0.7754	0.7311	0.7141

Other Information:

Specified Soil Properties	Density	Moisture
Tube Sample	pcf	%

CURVE DATA

Point	Normal Load psf	Peak Strength psf	Residual Strength psf
1	1000	736	539
2	2000	1443	1152
3	4000	2784	2143
4			
5			
6			

Displacement Rate: 0.04 in/min

Saturation: No

STRENGTH PROPERTIES

		Peak	Residual
Cohesion	psf	65	44
Friction	Degrees	34.3	27.9

Comments:

JLT Laboratories, Inc.

FIGURE- MR-3 IS- 18 ft

INPUT DATA FOR

JLT

ERM
"0283866
Black fine grained material
MR-3-IS-18 ft

Print Date: 03/04/2015
Project No.:15LS3165.01
Perf'd By: MS
Chk'd By: JBJr

UPPER GRAPH

Displacement inches	Point 1 Load lbs	Point 2 Load lbs	Point 3 Load lbs	Point 1 Stress psf	Point 2 Stress psf	Point 3 Stress psf
0.000	0.0	0.0	0.0	0.0	0.0	0.0
0.005	4.1	5.5	1.4	97.0	130.1	33.1
0.010	7.6	17.0	19.9	179.8	402.1	470.7
0.015	10.3	25.7	33.2	243.6	607.9	785.3
0.020	13.8	30.7	38.5	326.4	726.2	910.7
0.030	19.0	41.4	61.5	449.4	979.3	1454.7
0.040	21.1	47.1	80.8	499.1	1114.1	1911.2
0.050	25.4	51.5	94.5	600.8	1218.2	2235.3
0.060	27.0	55.1	102.7	638.7	1303.3	2429.3
0.070	28.4	57.5	108.7	671.8	1360.1	2571.2
0.080	29.2	59.3	111.2	690.7	1402.7	2630.3
0.090	30.5	60.3	114.6	721.4	1426.3	2710.8
0.100	30.8	60.8	117.0	728.5	1438.2	2767.5
0.110	31.0	61.0	117.3	733.3	1442.9	2774.6
0.120	31.1	60.4	117.4	735.6	1428.7	2777.0
0.130	30.6	59.6	117.7	723.8	1409.8	2784.1
0.140	30.6	59.2	115.7	723.8	1400.3	2736.8
0.150	30.5	56.9	114.7	721.4	1345.9	2713.1
0.160	30.4	55.0	110.5	719.1	1301.0	2613.8
0.170	29.8	53.2	107.4	704.9	1258.4	2540.4
0.180	29.2	52.2	105.0	690.7	1234.7	2483.7
0.190	28.4	51.0	103.0	671.8	1206.4	2436.4
0.200	28.1	51.0	102.0	664.7	1206.4	2412.7
0.220	27.6	49.8	101.0	652.9	1178.0	2389.1
0.240	27.5	49.6	99.8	650.5	1173.2	2360.7
0.260	27.4	49.4	99.7	648.1	1168.5	2358.3
0.280	26.5	49.5	97.6	626.8	1170.9	2308.6
0.300	26.2	49.3	97.1	619.7	1166.1	2296.8
0.320	25.3	48.2	96.3	598.4	1140.1	2277.9
0.340	25.0	48.6	95.8	591.4	1149.6	2266.1
0.360	24.4	48.7	95.4	577.2	1152.0	2256.6
0.380	24.0	48.9	95.0	567.7	1156.7	2247.1
0.400	23.6	48.6	94.3	558.2	1149.6	2230.6
0.425	23.2	48.8	94.0	548.8	1154.3	2223.5
0.450	23.1	48.9	93.7	546.4	1156.7	2216.4
0.475	22.9	48.7	93.2	541.7	1152.0	2204.6
0.500	22.9	48.6	92.8	541.7	1149.6	2195.1
0.550	22.8	48.7	92.1	539.3	1152.0	2178.5
0.057	22.8	48.5	90.9	539.3	1147.2	2150.2
0.600	22.7	48.7	90.7	536.9	1152.0	2145.4
0.650	22.8	48.7	90.6	539.3	1152.0	2143.1
0.700	22.8	48.7	90.6	539.3	1152.0	2143.1
0.750	22.8	48.7	90.6	539.3	1152.0	2143.1

LOWER GRAPH

Pn	Peak	Residual
1000	735.6	539.3
2000	1442.9	1152.0
4000	2784.1	2143.1

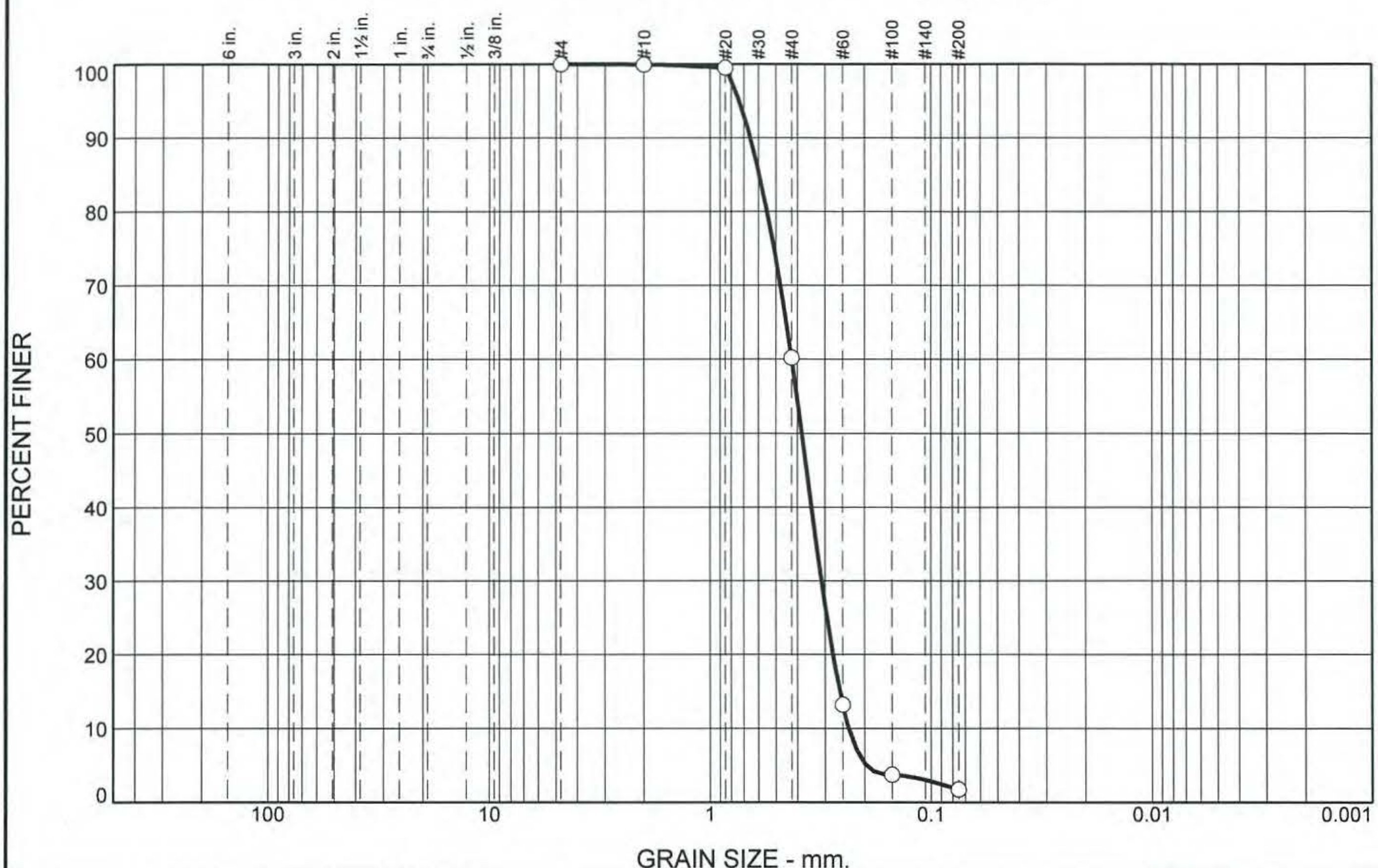
Engineering Properties

	Peak	Residual
Slope, m	0.681	0.529
Cohesion	65	43.8
Phi, degrees	34.25	27.88

FIGURE- MR-3 IS- 18 ft

JLT *Laboratories, Inc.*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	39.8	58.4	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.5		
#40	60.2		
#60	13.2		
#100	3.7		
#200	1.8		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6526 D_{85}= 0.5938 D_{60}= 0.4239
D_{50}= 0.3817 D_{30}= 0.3108 D_{15}= 0.2575
D_{10}= 0.2343 C_u= 1.81 C_c= 0.97

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 32.88%

Location: 0283866
Sample Number: MR-5-IS **Depth:** 31 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

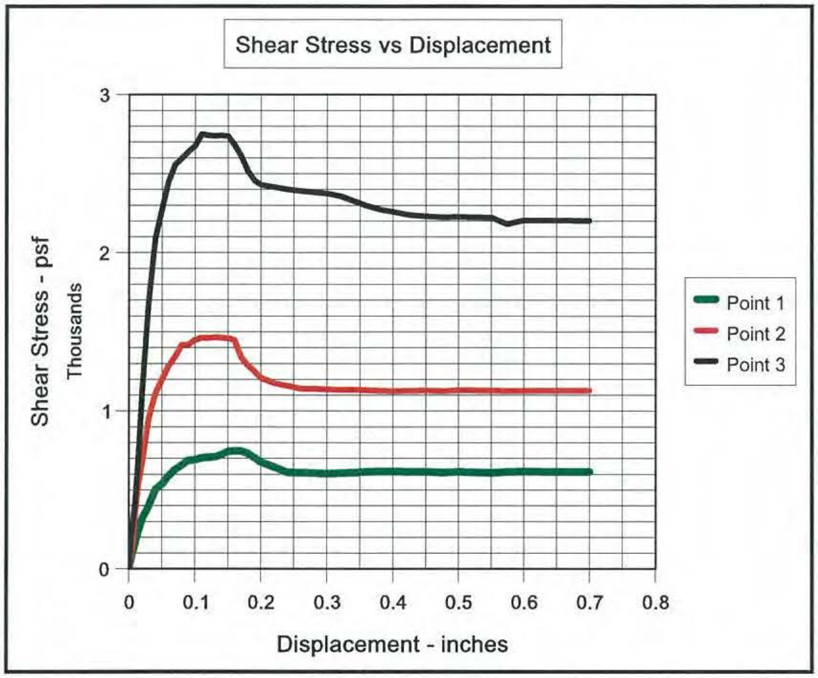
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

DIRECT SHEAR TEST RESULTS
ASTM D-3080 2.8-inch GeoTest Shear Box

JLT

Client:	ERM	Print Date:	03/04/2015
Project:	"0283866 MMGL PEO Portland	Project No.:	15LS3165.01
Material:	Black fine grained material	Perf'd By:	MS
Sample ID:	MR-5-IS-31 ft	Chk'd By:	JBJr



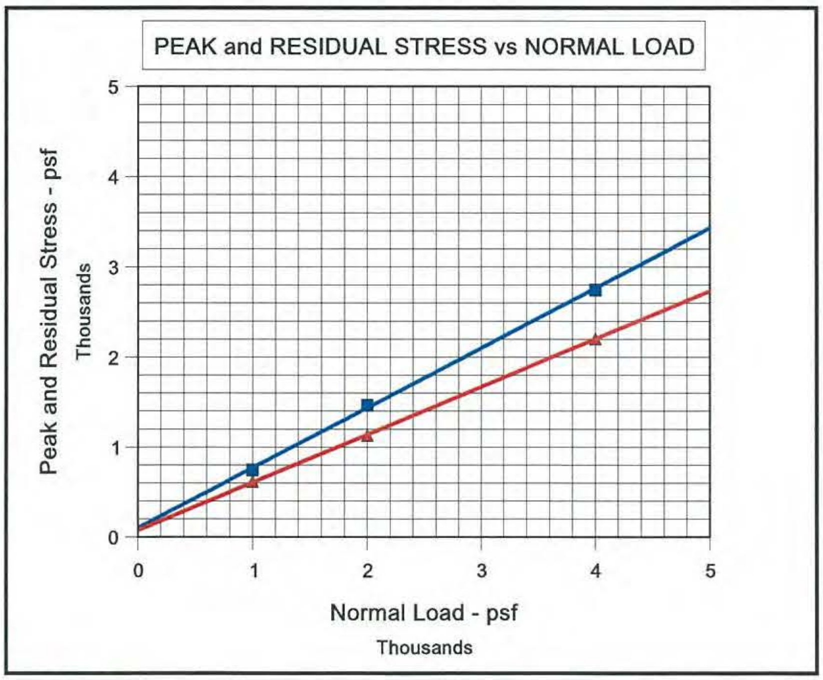
PHYSICAL PROPERTIES

Initial	Point 1	Point 2	Point 3
Moisture Cnt, %	31.83	29.57	29.64
Dry Density, pcf	63.9	66.0	66.4
Saturation , %	53.1	52.1	52.7
Void Ratio	1.5893	1.5044	1.4915

At Test	Point 1	Point 2	Point 3
Moisture Cnt, %	35.20	37.60	37.70
Dry Density, pcf	65.8	68.6	69.4
Saturation , %	55.8	55.5	56.7
Void Ratio	1.5116	1.4117	1.3844

Other Information:

Specified Soil Properties	Density	Moisture
Tube Sample	pcf	%



CURVE DATA

Point	Normal Load psf	Peak Strength psf	Residual Strength psf
1	1000	745	613
2	2000	1466	1128
3	4000	2749	2202
4			
5			
6			

Displacement Rate:	0.04	in/min
Saturation:	No	

STRENGTH PROPERTIES

		Peak	Residual
Cohesion	psf	104	76
Friction	Degrees	33.6	28.0

Comments:

JLT *Laboratories, Inc.*

FIGURE- MR-5 IS- 31 ft

INPUT DATA FOR

JLT

ERM
"0283866
Black fine grained material
MR-5-IS-31 ft

Print Date: 03/04/2015
Project No.:15LS3165.01
Perf'd By: MS
Chk'd By: JBJr

UPPER GRAPH

Displacement inches	Point 1 Load lbs	Point 2 Load lbs	Point 3 Load lbs	Point 1 Stress psf	Point 2 Stress psf	Point 3 Stress psf
0.000	0.0	0.0	0.0	0.0	0.0	0.0
0.005	3.9	4.0	10.8	92.3	94.6	255.5
0.010	7.0	15.0	18.0	165.6	354.8	425.8
0.015	10.3	23.0	30.0	243.6	544.0	709.6
0.020	13.3	28.4	47.0	314.6	671.8	1111.7
0.030	16.7	40.0	71.0	395.0	946.2	1679.4
0.040	21.1	46.8	88.1	499.1	1107.0	2083.9
0.050	22.6	50.7	96.0	534.6	1199.3	2270.8
0.060	24.8	54.2	103.4	586.6	1282.0	2445.8
0.070	26.5	56.8	108.1	626.8	1343.5	2557.0
0.080	27.7	60.0	109.7	655.2	1419.2	2594.8
0.090	29.0	60.0	111.5	686.0	1419.2	2637.4
0.100	29.2	61.3	113.1	690.7	1450.0	2675.3
0.110	29.7	61.9	116.2	702.5	1464.2	2748.6
0.120	29.9	61.9	115.9	707.3	1464.2	2741.5
0.130	30.0	62.0	115.8	709.6	1466.5	2739.1
0.140	30.5	61.9	115.9	721.4	1464.2	2741.5
0.150	31.4	61.7	115.7	742.7	1459.5	2736.8
0.160	31.5	61.2	113.3	745.1	1447.6	2680.0
0.170	31.5	56.6	110.4	745.1	1338.8	2611.4
0.180	30.8	54.4	106.4	728.5	1286.8	2516.8
0.190	29.7	52.9	103.8	702.5	1251.3	2455.3
0.200	28.5	51.1	102.7	674.1	1208.7	2429.3
0.220	27.2	49.7	102.1	643.4	1175.6	2415.1
0.240	25.8	49.0	101.5	610.3	1159.0	2400.9
0.260	25.7	48.2	101.1	607.9	1140.1	2391.4
0.280	25.6	48.2	100.7	605.5	1140.1	2382.0
0.300	25.4	48.1	100.4	600.8	1137.8	2374.9
0.320	25.6	48.0	99.7	605.5	1135.4	2358.3
0.340	25.7	48.0	98.4	607.9	1135.4	2327.6
0.360	25.9	47.9	97.1	612.6	1133.0	2296.8
0.380	26.0	47.7	96.1	615.0	1128.3	2273.2
0.400	26.0	47.6	95.5	615.0	1125.9	2259.0
0.425	25.9	47.7	94.6	612.6	1128.3	2237.7
0.450	25.9	47.8	94.3	612.6	1130.7	2230.6
0.475	25.8	47.6	94.0	610.3	1125.9	2223.5
0.500	25.9	47.9	94.1	612.6	1133.0	2225.8
0.550	25.7	47.8	93.9	607.9	1130.7	2221.1
0.057	25.9	47.7	92.1	612.6	1128.3	2178.5
0.600	26.0	47.7	93.2	615.0	1128.3	2204.6
0.650	25.9	47.7	93.2	612.6	1128.3	2204.6
0.700	25.9	47.7	93.1	612.6	1128.3	2202.2
0.750	25.9	47.7	93.1	612.6	1128.3	2202.2

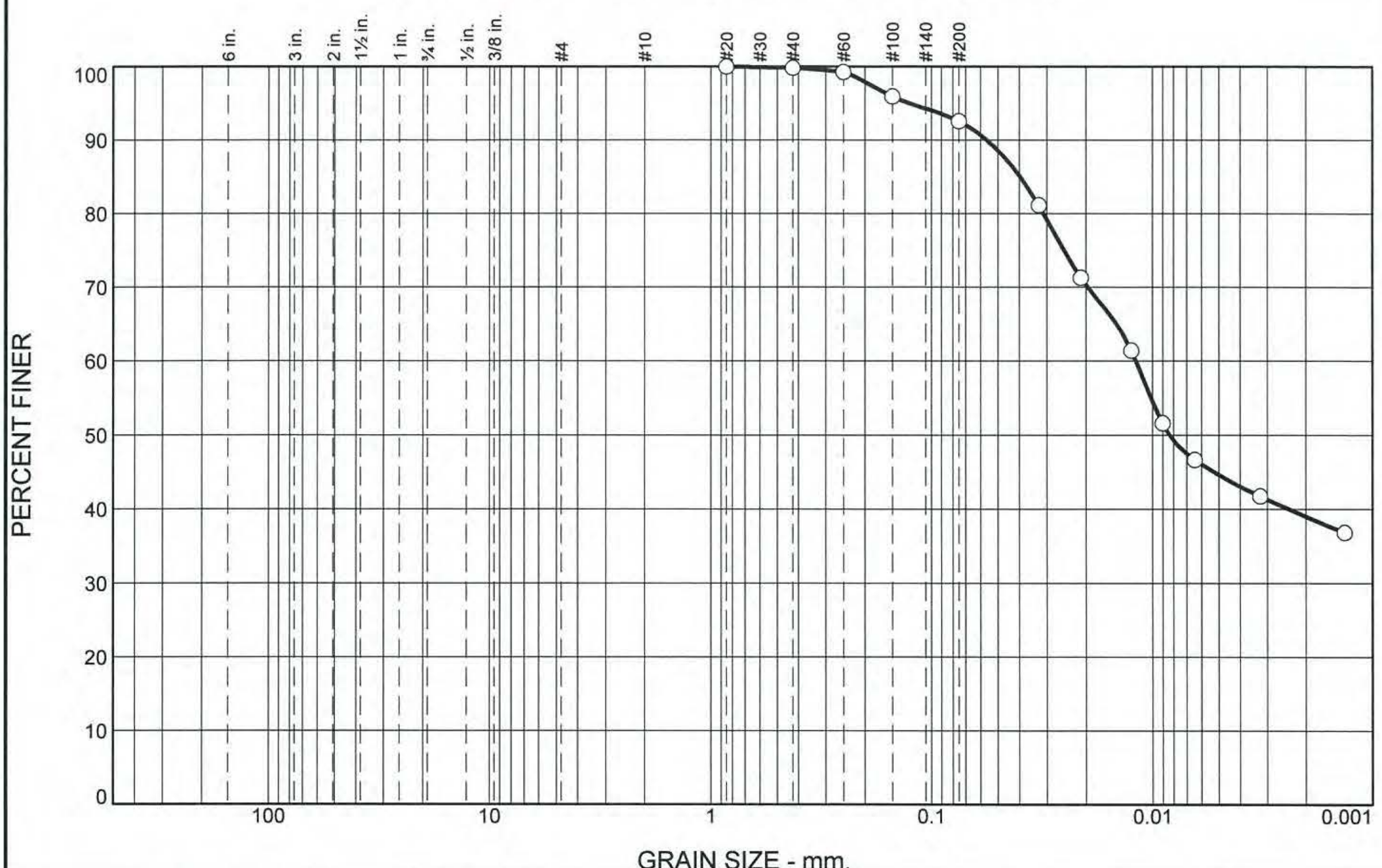
LOWER GRAPH		
Pn	Peak	Residual
1000	745.1	612.6
2000	1465.5	1128.3
4000	2748.6	2202.2

Engineering Properties		
	Peak	Residual
Slope, m	0.664	0.531
Cohesion	104	75.7
Phi, degrees	33.58	27.97

FIGURE- MR-5 IS- 31 ft

JLT *Laboratories, Inc.*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	7.2	48.0	44.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	99.8		
#60	99.3		
#100	95.9		
#200	92.6		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.0561 D_{85}= 0.0396 D_{60}= 0.0118
D_{50}= 0.0083 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

As-Rec'd M/C = 36.44%

Location: 0283866
Sample Number: MR-2-IS **Depth:** 35 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

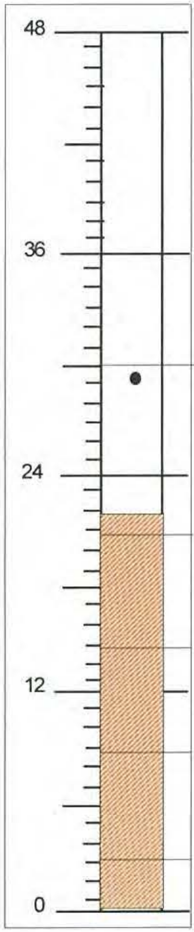
Canonsburg, PA

Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

TUBE LOG and DENSITY AND MOISTURE OF TUBE SAMPLES

Client :	ERM		Job No. :	15LS3165.01
Project :	MMGL PEO Portland		Date :	03/06/2015
Material ID :	Shelby Tube	No 0283866	Perf'd By :	MLB
Tube ID:	MR-2-IS 35 feet		Chk'd By :	JBJr



Top of Tube

Point 1 used for Density and Moisture Content
All Black fine Sand

Point 2: With 2 thin layers of Silt (0.3 " thick)

Point 3: With 3 thin layers of Gray-Black Silt

Spoil (loose material)

Moisture - Density Determination

Tare or Pan ID	Q-34				
Section Length	5.85				inches
Inside Diameter of Tube	2.83				inches
Wt. of Wet Soil + Tube + Tare	1662.5				grams
Wt. of Dry Soil + Tube + Tare	1373.3				grams
Weight of Tube Section only	466.4				grams
Wt. of Tare only	113.3				grams
Weight of Wet Soil only	1082.8				grams
Weight of Dry Soil Only	793.6				grams
Weight of Water in Sample	289.2				grams
Sample Volume	0.02129				cu ft
Moisture Content	36.44				%
Bulk Wet Density	112.0				pcf
Bulk Dry Density	82.1				pcf

Moisture Determinations Only

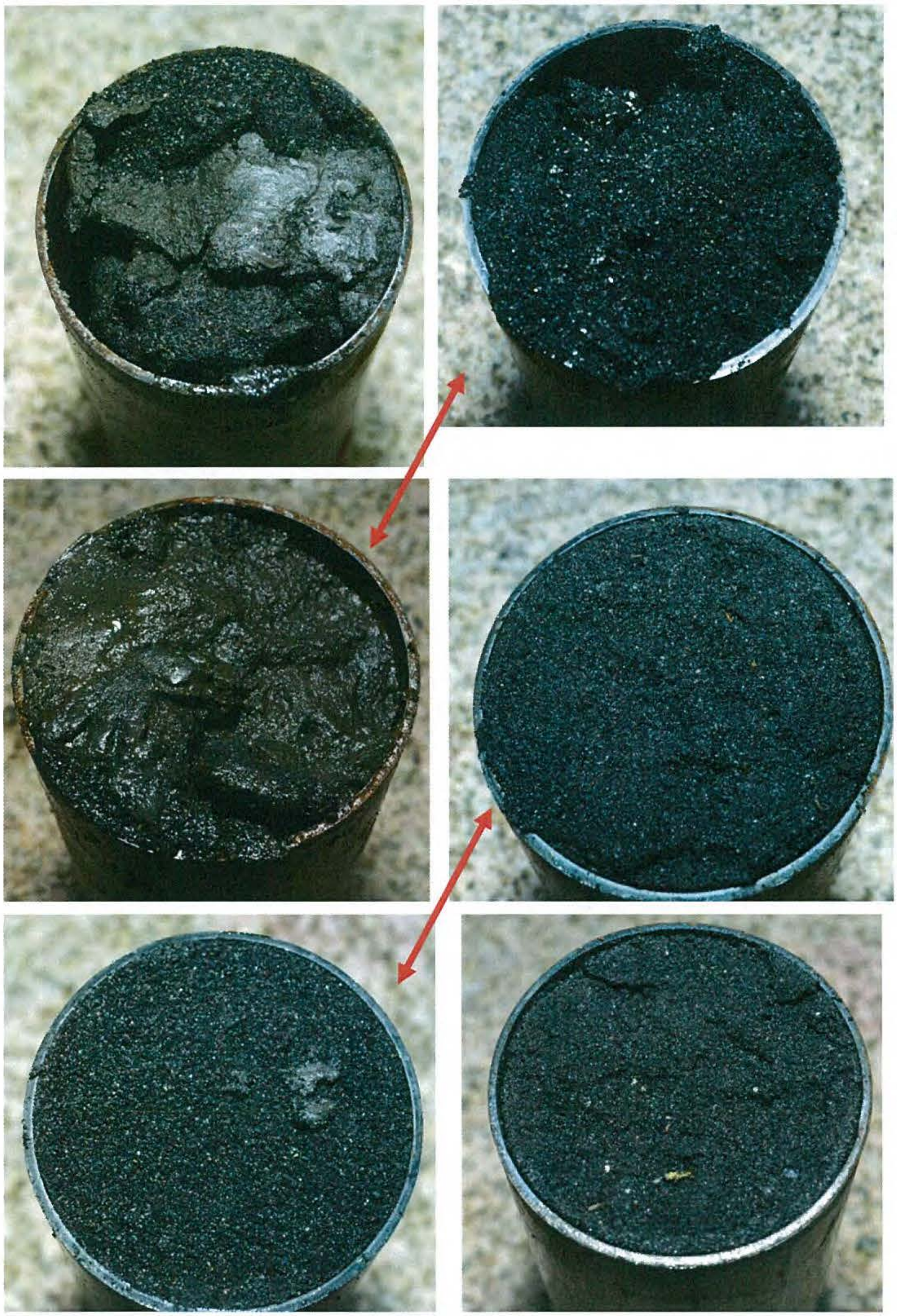
Tare /Pan ID				
Wet Soil plus Tare				grams
Dry Soil plus Tare				grams
Tare				grams
Water				grams
Dry Soil				grams
Moisture Content				%

LEGEND

Black Fine Sand

JLT *Laboratories, Inc.*

Top of Sample **Bottom of Sample**



CU SA 3

CU SA 2

CU SA 1

Shelby Tube : MR - 2 – IS - 35 feet
March 5,2015

Within each sample are thin layers of Silt with water accumulations on top of the silt.

JLT Laboratories, Inc.

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	18.7	40.9	40.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#60	99.8		
#100	89.6		
#200	81.3		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.1529 D_{85}= 0.1141 D_{60}= 0.0106
D_{50}= 0.0076 D_{30}= 0.0019 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 39.65%

Location: 0283866
Sample Number: MR-4-IS **Depth:** 34 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

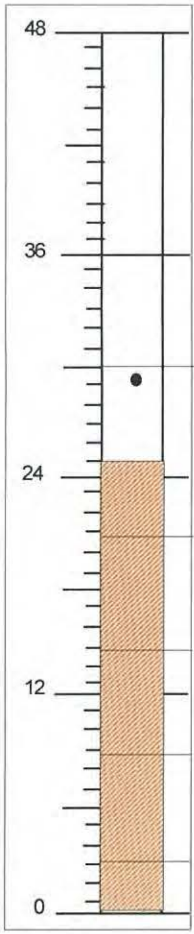
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

Tested By: RL **Checked By:** JB

TUBE LOG and DENSITY AND MOISTURE OF TUBE SAMPLES

JLT

Client :	ERM		Job No. :	15LS3165.01
Project :	MMGL PEO Portland		Date :	03/06/2015
Material ID :	Shelby Tube	No 0283866	Perf'd By :	MLB
Tube ID:	MR-4-IS 34 feet		Chk'd By :	JBJr



Top of Tube

Point 1: Black Sand with thin layers of black Silt

Point 2: Black Sand with 1 3" silt layer of black Silt

Point 3 used for Density and Moisture Content
Black fine Sand with two 2" layers of Silt

Spoil (loose material)

Moisture - Density Determination

Tare or Pan ID	P-23				
Section Length	5.57				inches
Inside Diameter of Tube	2.83				inches
Wt. of Wet Soil + Tube + Tare	1598.3				grams
Wt. of Dry Soil + Tube + Tare	1300.7				grams
Weight of Tube Section only	453.1				grams
Wt. of Tare only	97.0				grams
Weight of Wet Soil only	1048.2				grams
Weight of Dry Soil Only	750.6				grams
Weight of Water in Sample	297.6				grams
Sample Volume	0.02028				cu ft
Moisture Content	39.65				%
Bulk Wet Density	113.9				pcf
Bulk Dry Density	81.5				pcf

Moisture Determinations Only

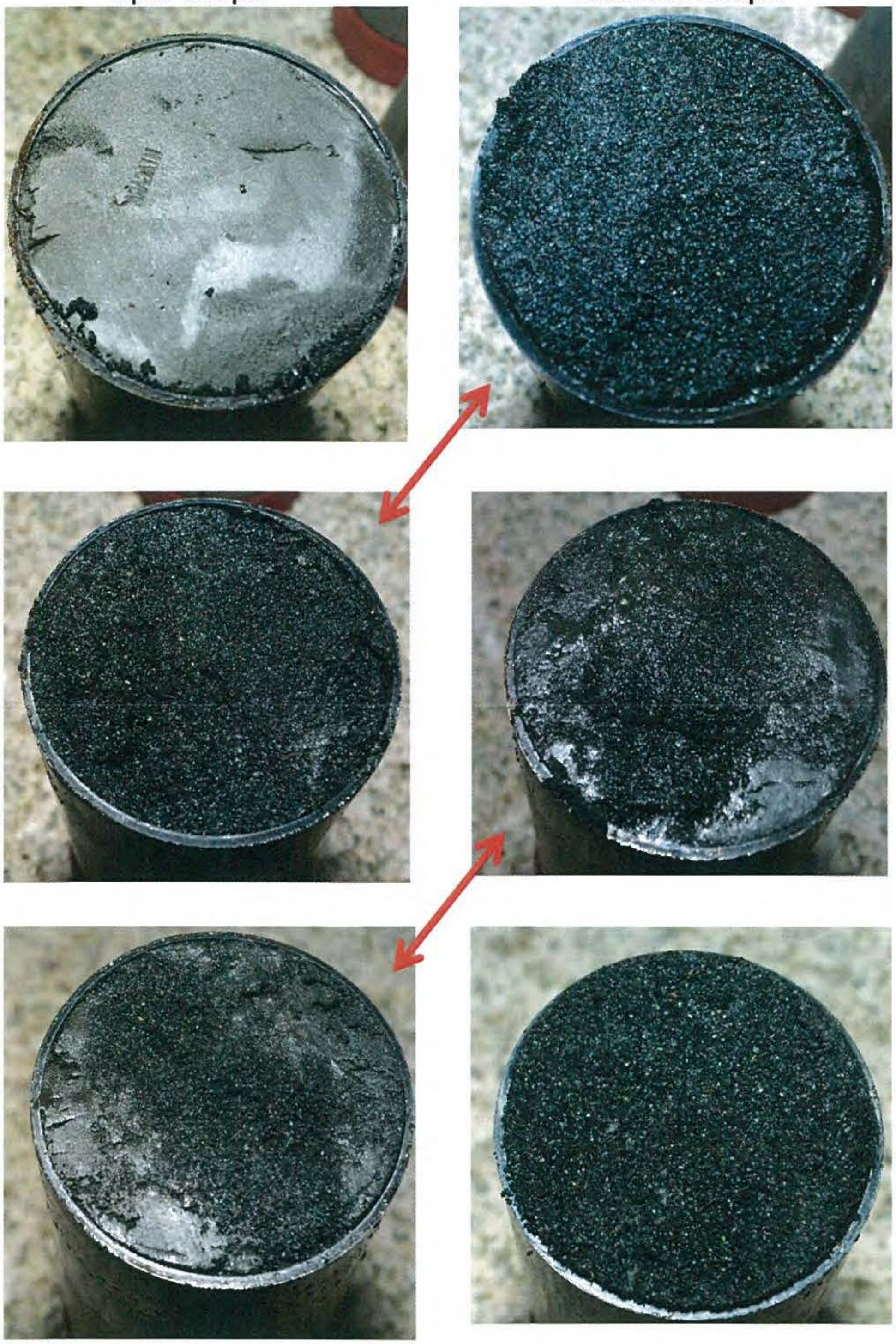
Tare /Pan ID				
Wet Soil plus Tare				grams
Dry Soil plus Tare				grams
Tare				grams
Water				grams
Dry Soil				grams
Moisture Content				%

LEGEND

Black Fine Sand

JLT *Laboratories, Inc.*

Top of Sample | Bottom of Sample



CU SA 1

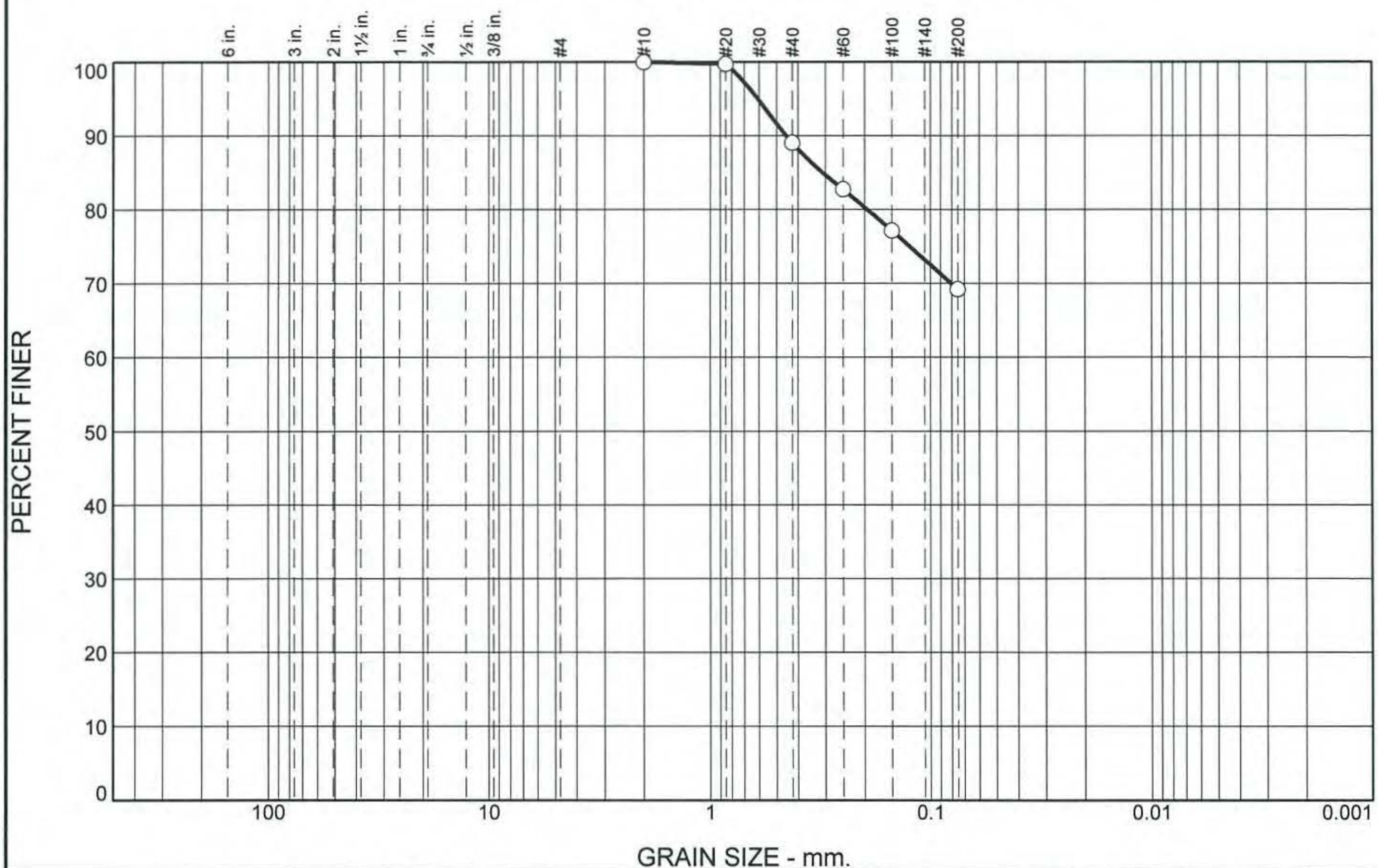
CU SA 2

CU SA 3

Shelby Tube : MR - 4 – IS - 34 feet

JLT Laboratories, Inc.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	10.9	19.9	69.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.7		
#40	89.1		
#60	82.8		
#100	77.2		
#200	69.2		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.4518 D_{85}= 0.3085 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

As-Rec'd M/C = 40.82%
Hydrometer is Not Applicable

Location: 0283866
Sample Number: MR-5-IS **Depth:** 33 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

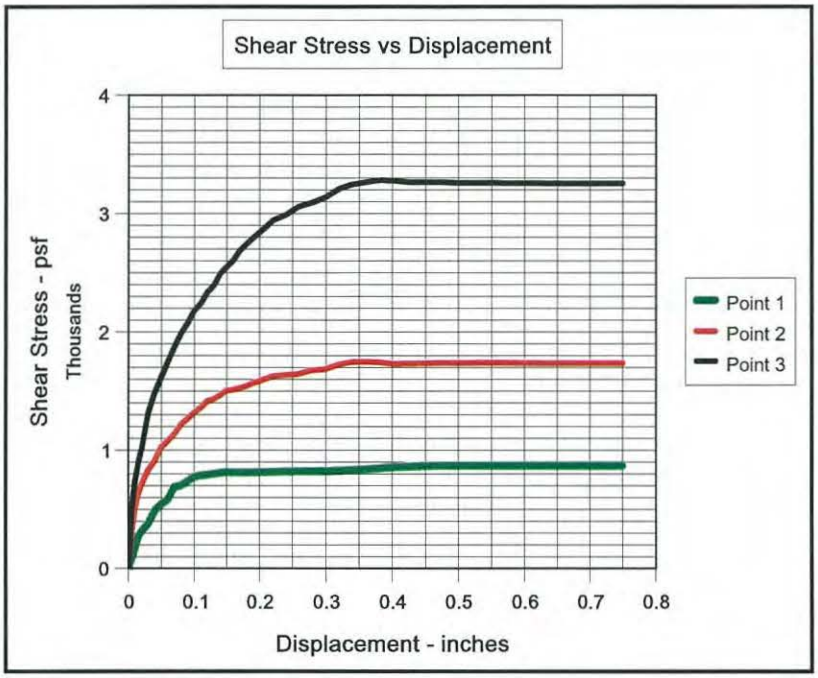
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

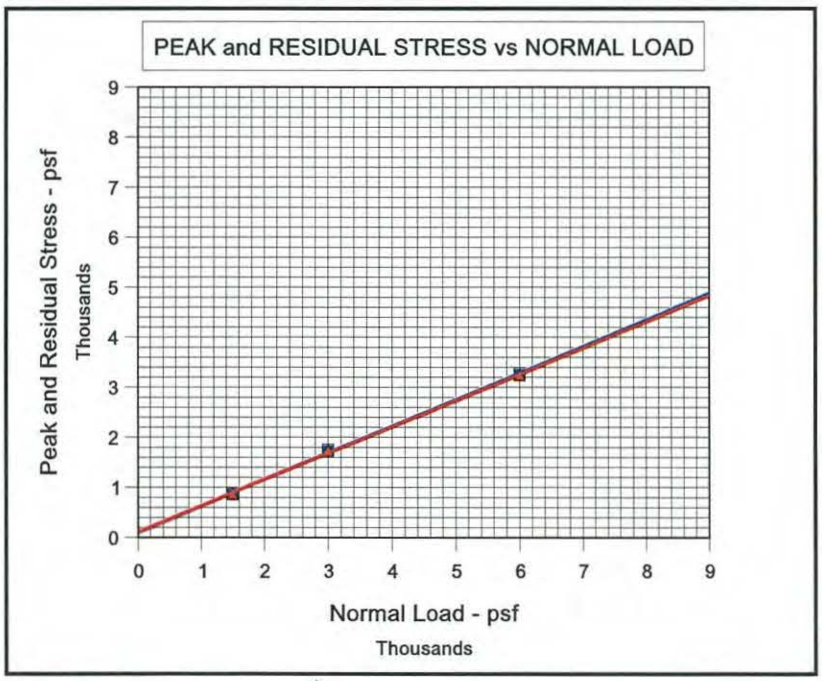
Tested By: RL **Checked By:** JB

DIRECT SHEAR TEST RESULTS

ASTM D-3080 2.8-inch GeoTest Shear Box

Client:	ERM		Print Date:	03/06/2015
Project:	"0283866		Project No.:	15LS3165.01
Material:	Gray-Black Silt	Shelby Tube	Perf'd By:	MS
Sample ID:	MR-5-IS- 33 ft		Chk'd By:	JBJr





COMPACTION PROPERTIES

Initial	Point 1	Point 2	Point 3
Moisture Cnt, %	43.86	52.07	45.90
Dry Density, pcf	77.2	71.8	74.4
Saturation , %	101.4	105.5	99.2
Void Ratio	1.1508	1.3122	1.2311

At Test	Point 1	Point 2	Point 3
Moisture Cnt, %	42.51	47.42	44.30
Dry Density, pcf	77.9	73.4	76.2
Saturation , %	100.0	100.0	100.0
Void Ratio	1.1307	1.2614	1.1783

Other Information:

Specified Soil Properties	Density pcf	Moisture %

CURVE DATA

Point	Normal Load psf	Peak Strength psf	Residual Strength psf
1	1500	877	877
2	3000	1754	1742
3	6000	3281	3255
4			
5			
6			

Displacement Rate: 0.04 in/min

Saturation: Yes

STRENGTH PROPERTIES

		Peak	Residual
Cohesion	psf	113	120
Friction	Degrees	28.0	27.7

Comments:

JLT Laboratories, Inc.

FIGURE - MR-5-IS-33

INPUT DATA FOR

JLT

ERM
"0283866
Gray-Black Silt

MR-5-IS- 33 ft

Print Date: 03/06/2015
Project No.:15LS3165.01
Perf'd By: MS

Chk'd By: JBJr

UPPER GRAPH

Displacement inches	Point 1 Load lbs	Point 2 Load lbs	Point 3 Load lbs	Point 1 Stress psf	Point 2 Stress psf	Point 3 Stress psf
0.000	0.0	0.0	0.0	0.0	0.0	0.0
0.005	4.0	13.5	21.0	93.5	315.7	491.1
0.010	7.3	22.2	31.2	170.7	519.2	729.6
0.015	11.6	27.0	37.8	271.3	631.4	884.0
0.020	13.7	30.6	42.9	320.4	715.6	1003.3
0.030	16.2	35.7	55.6	378.8	834.9	1300.3
0.040	21.0	39.0	63.3	491.1	912.0	1480.3
0.050	23.5	44.1	69.2	549.6	1031.3	1618.3
0.060	25.1	46.3	74.7	587.0	1082.8	1746.9
0.070	29.8	48.9	80.1	696.9	1143.6	1873.2
0.080	30.4	52.3	84.9	710.9	1223.1	1985.5
0.090	31.8	54.4	88.7	743.7	1272.2	2074.3
0.100	33.5	56.6	93.2	783.4	1323.6	2179.6
0.110	33.9	58.5	95.8	792.8	1368.1	2240.4
0.120	34.2	60.8	99.7	799.8	1421.9	2331.6
0.130	34.5	61.6	102.4	806.8	1440.6	2394.7
0.140	34.9	62.9	106.4	816.2	1471.0	2488.2
0.150	35.1	64.6	109.0	820.8	1510.7	2549.1
0.160	35.0	64.8	111.3	818.5	1515.4	2602.8
0.170	35.0	65.4	114.9	818.5	1529.4	2687.0
0.180	35.0	66.1	117.2	818.5	1545.8	2740.8
0.190	35.0	67.3	119.4	818.5	1573.9	2792.3
0.200	35.1	67.9	121.4	820.8	1587.9	2839.0
0.220	35.2	69.8	125.8	823.2	1632.3	2941.9
0.240	35.3	70.2	127.8	825.5	1641.7	2988.7
0.260	35.4	70.6	130.8	827.9	1651.0	3058.9
0.280	35.5	72.0	132.2	830.2	1683.8	3091.6
0.300	35.6	72.3	134.2	832.5	1690.8	3138.4
0.320	35.7	74.1	137.2	834.9	1732.9	3208.5
0.340	35.9	75.0	138.8	839.6	1753.9	3245.9
0.360	36.1	75.0	139.6	844.2	1753.9	3264.7
0.380	36.5	74.9	140.3	853.6	1751.6	3281.0
0.400	36.9	74.3	140.2	862.9	1737.6	3278.7
0.425	37.2	74.4	139.7	870.0	1739.9	3267.0
0.450	37.4	74.5	139.6	874.6	1742.2	3264.7
0.475	37.5	74.6	139.6	877.0	1744.6	3264.7
0.500	37.5	74.7	139.4	877.0	1746.9	3260.0
0.550	37.5	74.8	139.4	877.0	1749.3	3260.0
0.057	37.5	74.8	139.3	877.0	1749.3	3257.6
0.600	37.5	74.6	139.3	877.0	1744.6	3257.6
0.650	37.5	74.5	139.2	877.0	1742.2	3255.3
0.700	37.5	74.5	139.2	877.0	1742.2	3255.3
0.750	37.5	74.5	139.2	877.0	1742.2	3255.3

LOWER GRAPH

Pn	Peak	Residual
1500	877	877.0
3000	1753.9	1742.2
6000	3281	3255.3

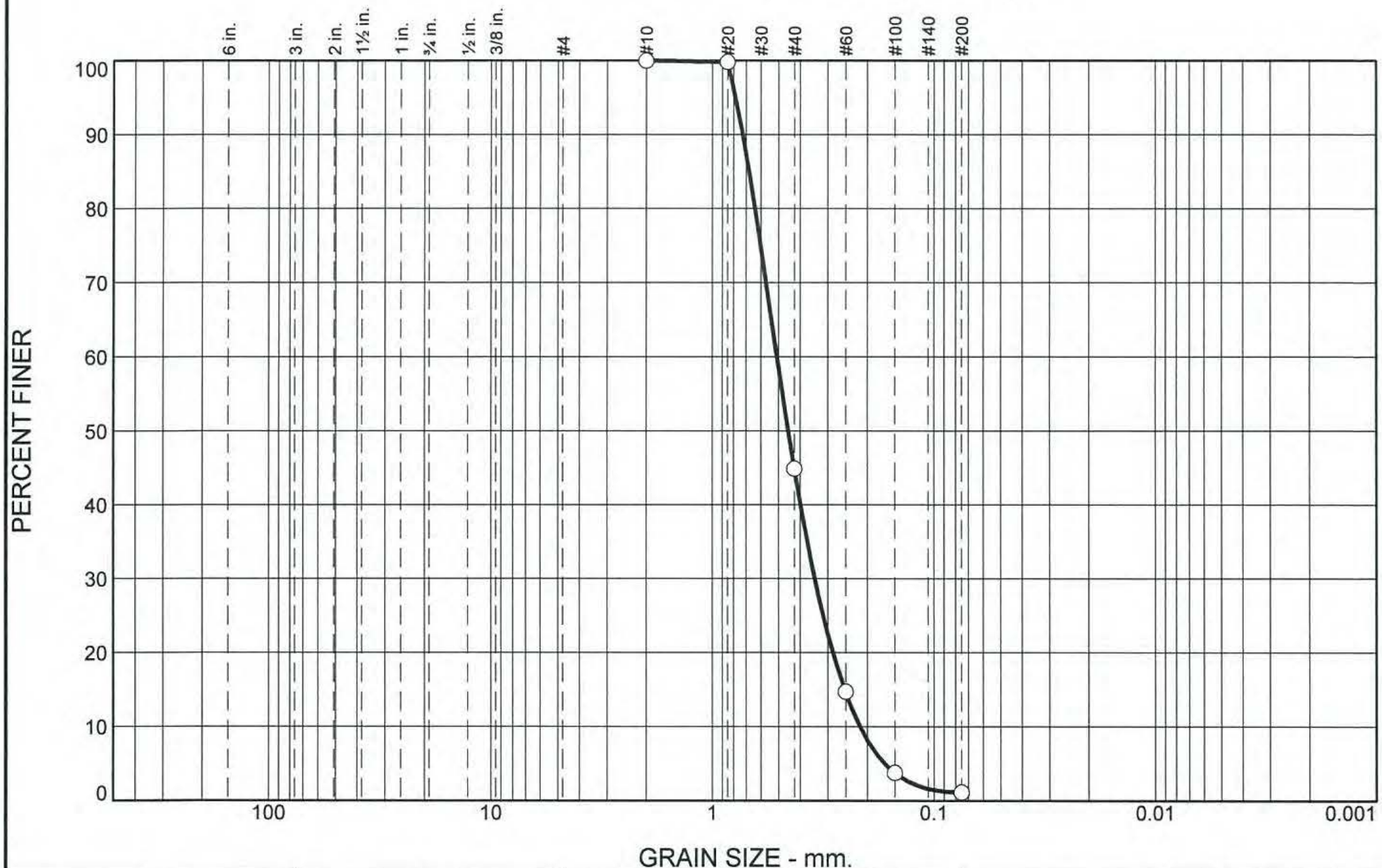
Engineering Properties

	Peak	Residual
Slope, m	0.531	0.525
Cohesion	113	120
Phi, degrees	27.97	27.70

FIGURE - MR-5-IS-33

JLT Laboratories, Inc.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	55.1	43.7	1.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	44.9		
#60	14.7		
#100	3.8		
#200	1.2		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7250 D_{85}= 0.6786 D_{60}= 0.5080
D_{50}= 0.4526 D_{30}= 0.3433 D_{15}= 0.2519
D_{10}= 0.2146 C_u= 2.37 C_c= 1.08

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 26.09%

Location: 0283866
Sample Number: MR-3-IS **Depth:** 42 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

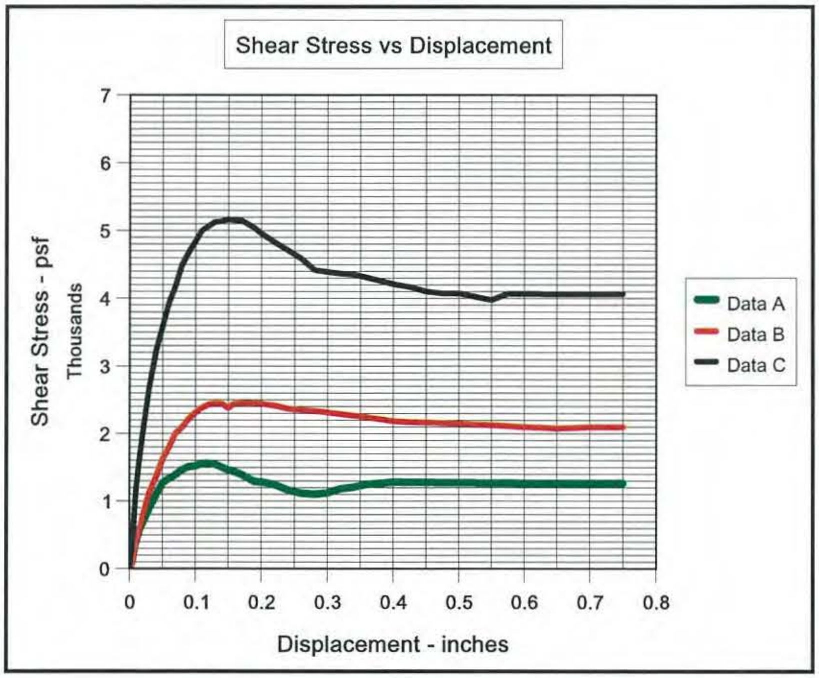
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

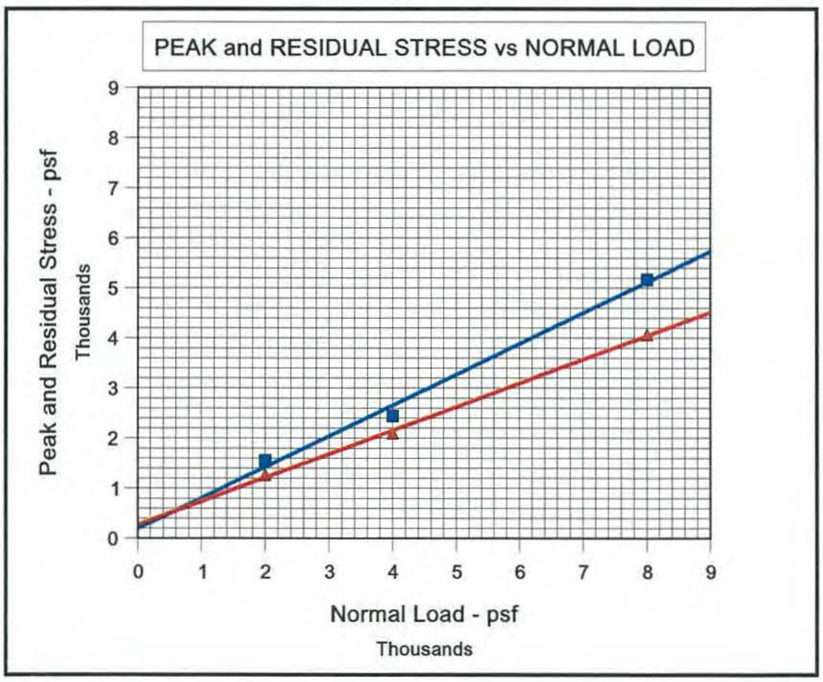
Tested By: RL **Checked By:** JB

DIRECT SHEAR TEST RESULTS
ASTM D-3080 2.8-inch GeoTest Shear Box

JLT

Client:	ERM		Print Date:	03/05/2015
Project:	"0283866		Project No.:	15LS3165.01
Material:	Lower Sand	Shelby Tube	Perf'd By:	MS
Sample ID:	MR-3 IS- 42 ft		Chk'd By:	JBJr





TION PROPERTIES

Initial	Point 1	Point 2	Point 3
Moisture Cnt, %	27.38	28.33	29.07
Dry Density, pcf	92.1	90.3	89.6
Saturation , %	90.9	89.8	90.8
Void Ratio	0.8013	0.8388	0.8515

At Test	Point 1	Point 2	Point 3
Moisture Cnt, %	29.50	29.43	29.22
Dry Density, pcf	93.0	93.1	93.4
Saturation , %	100.0	100.0	100.0
Void Ratio	0.7848	0.7829	0.7771

Other Information:

Specified Soil Properties	Density pcf	Moisture %

CURVE DATA

Point	Normal Load psf	Peak Strength psf	Residual Strength psf
1	2000	1555	1263
2	4000	2449	2098
3	8000	5168	4064
4			
5			
6			

Displacement Rate: 0.04 in/min
Saturation: Yes

STRENGTH PROPERTIES

		Peak	Residual
Cohesion	psf	195	279
Friction	Degrees	31.5	25.2

Comments:

JLT Laboratories, Inc.

FIGURE - MR-3-IS-42

INPUT DATA FOR

JLT

ERM
"0283866
Lower Sand

MR-3 IS- 42 ft

Print Date: 03/05/2015
Project No.:15LS3165.01
Perf'd By: MS

Chk'd By: JBJr

UPPER GRAPH

Displacement inches	Point 1 Load lbs	Point 2 Load lbs	Point 3 Load lbs	Point 1 Stress psf	Point 2 Stress psf	Point 3 Stress psf
0.000	0.0	0.0	0.0	0.0	0.0	0.0
0.005	8.6	4.0	18.0	201.1	93.5	420.9
0.010	16.9	16.5	49.0	395.2	385.9	1145.9
0.015	24.3	23.3	68.1	568.3	544.9	1592.6
0.020	29.1	33.0	85.5	680.5	771.7	1999.5
0.030	38.0	48.0	114.2	888.7	1122.5	2670.7
0.040	46.4	57.8	137.2	1085.1	1351.7	3208.5
0.050	54.1	69.5	152.9	1265.2	1625.3	3575.7
0.060	57.0	77.1	167.9	1333.0	1803.0	3926.5
0.070	59.2	86.0	178.9	1384.4	2011.2	4183.7
0.080	62.5	89.5	191.9	1461.6	2093.0	4487.7
0.090	64.4	95.0	200.0	1506.0	2221.7	4677.2
0.100	64.8	98.8	206.9	1515.4	2310.5	4838.5
0.110	66.5	101.8	213.7	1555.2	2380.7	4997.5
0.120	66.4	104.0	216.4	1552.8	2432.1	5060.7
0.130	66.0	104.7	219.2	1543.5	2448.5	5126.2
0.140	64.1	104.5	219.6	1499.0	2443.8	5135.5
0.150	62.2	101.6	221.0	1454.6	2376.0	5168.3
0.160	61.2	104.6	220.3	1431.2	2446.2	5151.9
0.170	59.3	104.8	220.0	1386.8	2450.8	5144.9
0.180	57.2	105.0	217.7	1337.7	2455.5	5091.1
0.190	55.0	104.8	215.3	1286.2	2450.8	5035.0
0.200	54.7	104.5	211.7	1279.2	2443.8	4950.8
0.220	53.2	103.3	206.3	1244.1	2415.8	4824.5
0.240	49.7	101.3	201.3	1162.3	2369.0	4707.6
0.260	47.7	100.7	196.3	1115.5	2354.9	4590.6
0.280	47.1	100.0	188.9	1101.5	2338.6	4417.6
0.300	47.9	99.0	187.7	1120.2	2315.2	4389.5
0.320	50.5	98.0	186.6	1181.0	2291.8	4363.8
0.340	51.5	97.0	186.1	1204.4	2268.4	4352.1
0.360	53.3	96.0	184.0	1246.5	2245.0	4303.0
0.380	54.0	94.8	182.0	1262.8	2217.0	4256.2
0.400	54.8	93.7	180.1	1281.5	2191.2	4211.8
0.425	54.5	93.0	178.2	1274.5	2174.9	4167.3
0.450	54.5	92.7	175.4	1274.5	2167.9	4101.9
0.475	54.4	92.3	174.1	1272.2	2158.5	4071.5
0.500	54.3	92.0	174.1	1269.8	2151.5	4071.5
0.550	54.2	91.1	170.0	1267.5	2130.4	3975.6
0.057	54.2	90.5	174.0	1267.5	2116.4	4069.1
0.600	54.0	90.0	173.9	1262.8	2104.7	4066.8
0.650	54.0	89.0	173.8	1262.8	2081.3	4064.5
0.700	54.0	89.7	173.8	1262.8	2097.7	4064.5
0.750	54.0	89.7	173.8	1262.8	2097.7	4064.5

LOWER GRAPH

Pn	Peak	Residual
2000	1555.2	1262.8
4000	2448.5	2097.7
8000	5168.3	4064.5

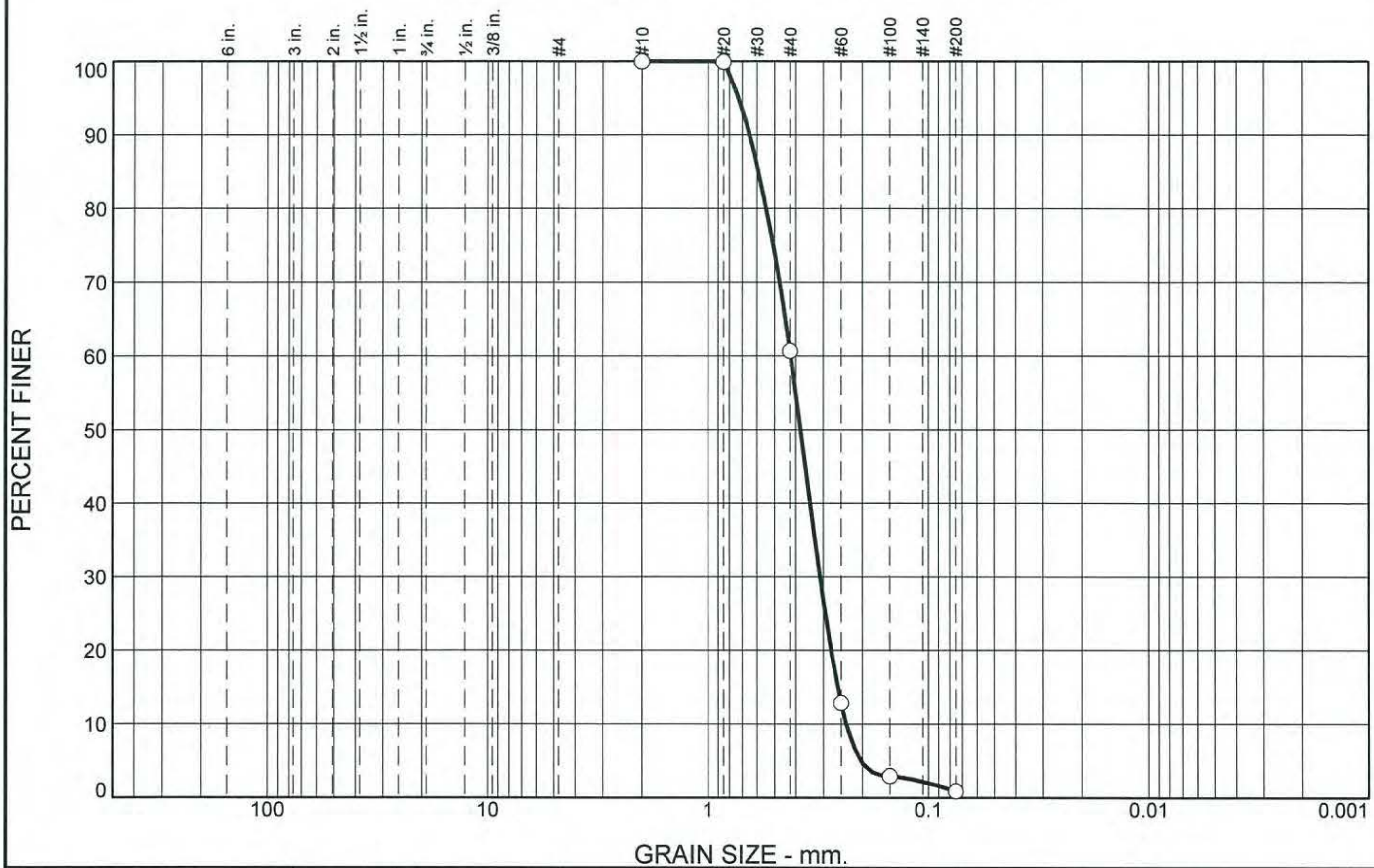
Engineering Properties

	Peak	Residual
Slope, m	0.613	0.47
Cohesion	195	279
Phi, degrees	31.51	25.17

JLT *Laboratories, Inc.*

FIGURE - MR-3-IS-42

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	39.3	59.8	0.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	60.7		
#60	12.9		
#100	3.0		
#200	0.9		

* (no specification provided)

Material Description

Shelby Tube

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6467 D_{85}= 0.5890 D_{60}= 0.4217
D_{50}= 0.3802 D_{30}= 0.3107 D_{15}= 0.2585
D_{10}= 0.2364 C_u= 1.78 C_c= 0.97

Classification

USCS= SP AASHTO=

Remarks

As-Rec'd M/C = 27.58%

Location: 0283866
Sample Number: MR-4-IS **Depth:** 50 ft **Date:** 03/09/2015

JLT Laboratories, Inc.

Canonsburg, PA

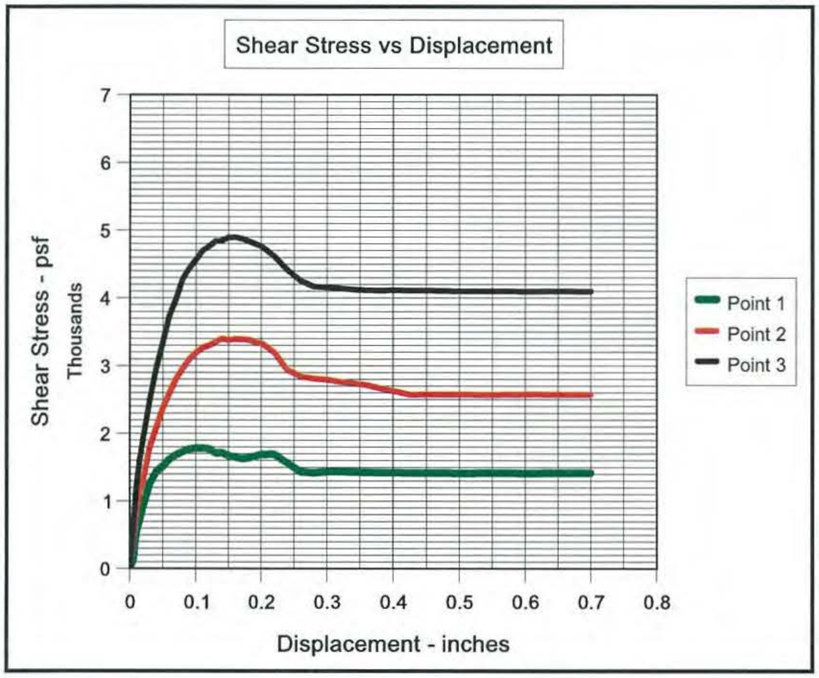
Client: ERM
Project: MMGL PEO Portland
ERM Project No: 0283866
Project No: 15LS3165.01 **Figure**

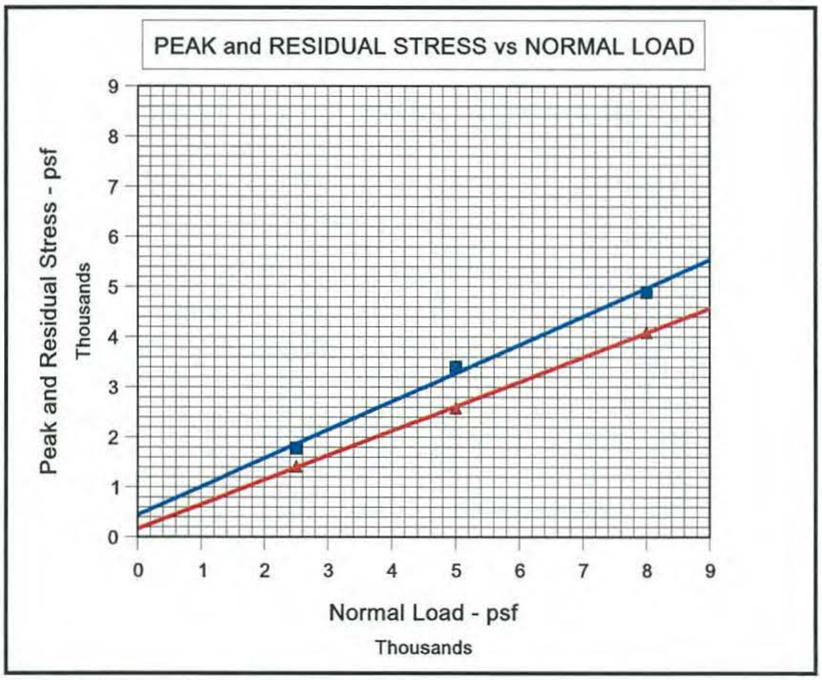
Tested By: RL **Checked By:** JB

DIRECT SHEAR TEST RESULTS
ASTM D-3080 2.8-inch GeoTest Shear Box

JLT

Client:	ERM		Print Date:	03/04/2015
Project:	"0283866		Project No.:	15LS3165.01
Material:	Lower Sand	Shelby Tube	Perf'd By:	MS
Sample ID:	MR-4 IS- 50 ft		Chk'd By:	JBJr





TION PROPERTIES

Initial	Point 1	Point 2	Point 3
Moisture Cnt, %	29.53	34.20	32.75
Dry Density, pcf	92.2	86.2	92.1
Saturation , %	98.2	98.4	108.5
Void Ratio	0.8003	0.9250	0.8030

At Test	Point 1	Point 2	Point 3
Moisture Cnt, %	29.65	29.00	28.30
Dry Density, pcf	92.8	93.7	94.7
Saturation , %	100.0	100.0	100.0
Void Ratio	0.7886	0.7714	0.7527

Other Information:

Specified Soil Properties	Density pcf	Moisture %

CURVE DATA

Point	Normal Load psf	Peak Strength psf	Residual Strength psf
1	2500	1777	1413
2	5000	3400	2577
3	8000	4895	4095
4			
5			
6			

Displacement Rate:	0.04	in/min
Saturation:	Yes	

STRENGTH PROPERTIES

		Peak	Residual
Cohesion	psf	441	172
Friction	Degrees	29.5	26.0

Comments:

JLT Laboratories, Inc.

FIGURE - MR-4-IS-50

INPUT DATA FOR

ERM
"0283866
Lower Sand

MR-4 IS- 50 ft

Print Date: 03/04/2015
Project No.:15LS3165.01
Perf'd By: MS

Chk'd By: JBJr

UPPER GRAPH

Displacement inches	Point 1 Load lbs	Point 2 Load lbs	Point 3 Load lbs	Point 1 Stress psf	Point 2 Stress psf	Point 3 Stress psf
0.000	0.0	0.0	0.0	0.0	0.0	0.0
0.005	4.5	18.0	23.3	105.2	420.9	544.9
0.010	22.5	35.0	50.4	526.2	818.5	1178.6
0.015	30.3	48.0	67.2	708.6	1122.5	1571.5
0.020	39.3	55.2	81.6	919.1	1290.9	1908.3
0.030	53.3	76.1	105.3	1246.5	1779.7	2462.5
0.040	61.0	88.6	126.1	1426.5	2072.0	2948.9
0.050	64.5	101.5	142.7	1508.4	2373.7	3337.2
0.060	68.9	110.6	159.4	1611.3	2586.5	3727.7
0.070	71.7	120.2	170.4	1676.8	2811.0	3984.9
0.080	73.7	126.3	182.8	1723.5	2953.6	4274.9
0.090	75.3	132.5	189.6	1761.0	3098.6	4433.9
0.100	76.0	136.6	194.9	1777.3	3194.5	4557.9
0.110	76.0	139.8	200.6	1777.3	3269.3	4691.2
0.120	75.5	141.2	203.4	1765.6	3302.1	4756.7
0.130	73.0	143.5	206.9	1707.2	3355.9	4838.5
0.140	73.1	145.4	207.2	1709.5	3400.3	4845.5
0.150	71.1	144.6	209.1	1662.7	3381.6	4890.0
0.160	70.3	145.3	209.3	1644.0	3398.0	4894.6
0.170	69.4	145.0	208.6	1623.0	3390.9	4878.3
0.180	69.8	144.8	206.9	1632.3	3386.3	4838.5
0.190	70.8	143.1	205.4	1655.7	3346.5	4803.4
0.200	72.0	142.6	203.8	1683.8	3334.8	4766.0
0.220	72.1	137.0	197.5	1686.1	3203.9	4618.7
0.240	66.7	125.8	188.8	1559.8	2941.9	4415.2
0.260	61.1	121.5	181.8	1428.9	2841.4	4251.5
0.280	60.4	120.4	178.2	1412.5	2815.6	4167.3
0.300	61.3	119.8	177.7	1433.5	2801.6	4155.7
0.320	61.2	118.2	177.1	1431.2	2764.2	4141.6
0.340	61.1	117.4	176.3	1428.9	2745.5	4122.9
0.360	60.8	116.2	176.0	1421.9	2717.4	4115.9
0.380	60.7	114.3	175.8	1419.5	2673.0	4111.2
0.400	60.6	112.6	175.9	1417.2	2633.2	4113.6
0.425	60.5	110.2	175.8	1414.8	2577.1	4111.2
0.450	60.5	110.3	175.7	1414.8	2579.5	4108.9
0.475	60.5	110.4	175.6	1414.8	2581.8	4106.5
0.500	60.3	110.3	175.4	1410.2	2579.5	4101.9
0.550	60.5	110.2	175.3	1414.8	2577.1	4099.5
0.057	60.4	110.3	175.3	1412.5	2579.5	4099.5
0.600	60.2	110.4	175.2	1407.8	2581.8	4097.2
0.650	60.5	110.2	175.3	1414.8	2577.1	4099.5
0.700	60.4	110.2	175.1	1412.5	2577.1	4094.9
0.750	60.4	110.2	175.1	1412.5	2577.1	4094.9

LOWER GRAPH		
Pn	Peak	Residual
2500	1777.3	1412.5
5000	3400.3	2577.1
8000	4894.6	4094.9

Engineering Properties		
	Peak	Residual
Slope, m	0.565	0.488
Cohesion	441	172
Phi, degrees	29.47	26.01

FIGURE - MR-4-IS-50

JLT Laboratories, Inc.

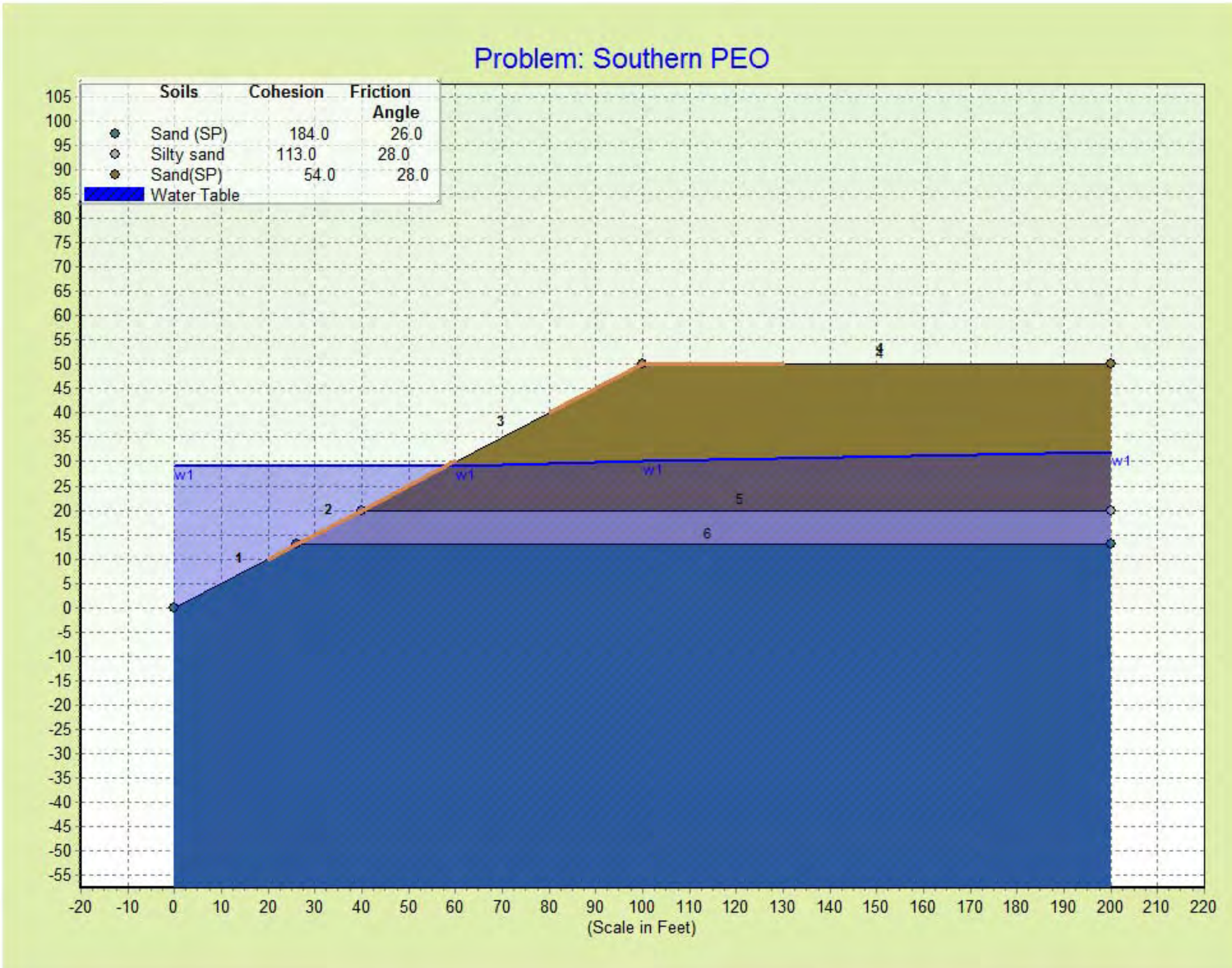
Appendix C
Stability Analyses

The purpose of the calculations presented herein is to evaluate the stability of the riverbank slope and the minimum setback of the proposed slurry wall from the riverbank crest, as discussed in the Memorandum. Stability analyses for both rotational and sliding block failures were performed for the following scenarios, and are presented herein.

- Existing Riverbank, Normal Groundwater Condition.
- Existing Riverbank, Rapid Drawdown Condition.
- During Construction, Normal Groundwater Condition.
- During Construction, Rapid Drawdown Condition.
- Post-Construction, Normal Groundwater Condition.
- Post-Construction, Rapid Drawdown Condition.

Appendix C.1
Existing Riverbank, Normal
Groundwater Condition

================== DATA SUMMARY =====================



Profile Data

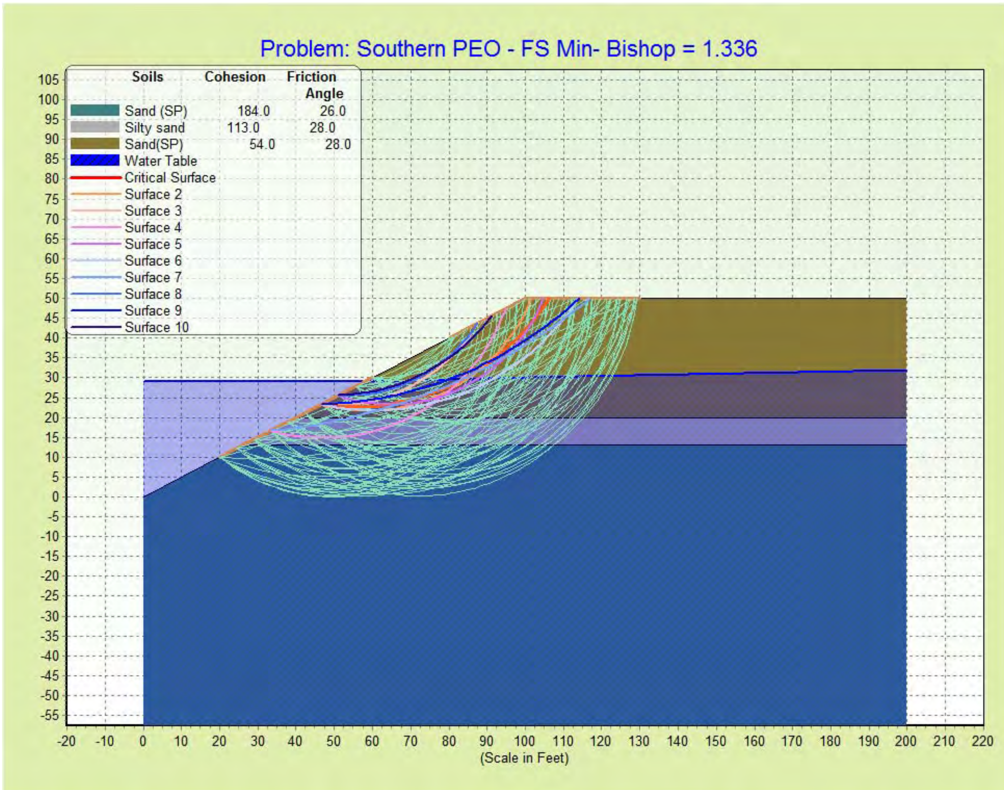
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	200	50	1
5	40	20	200	20	2
6	26	13	200	13	3

Soil Properties

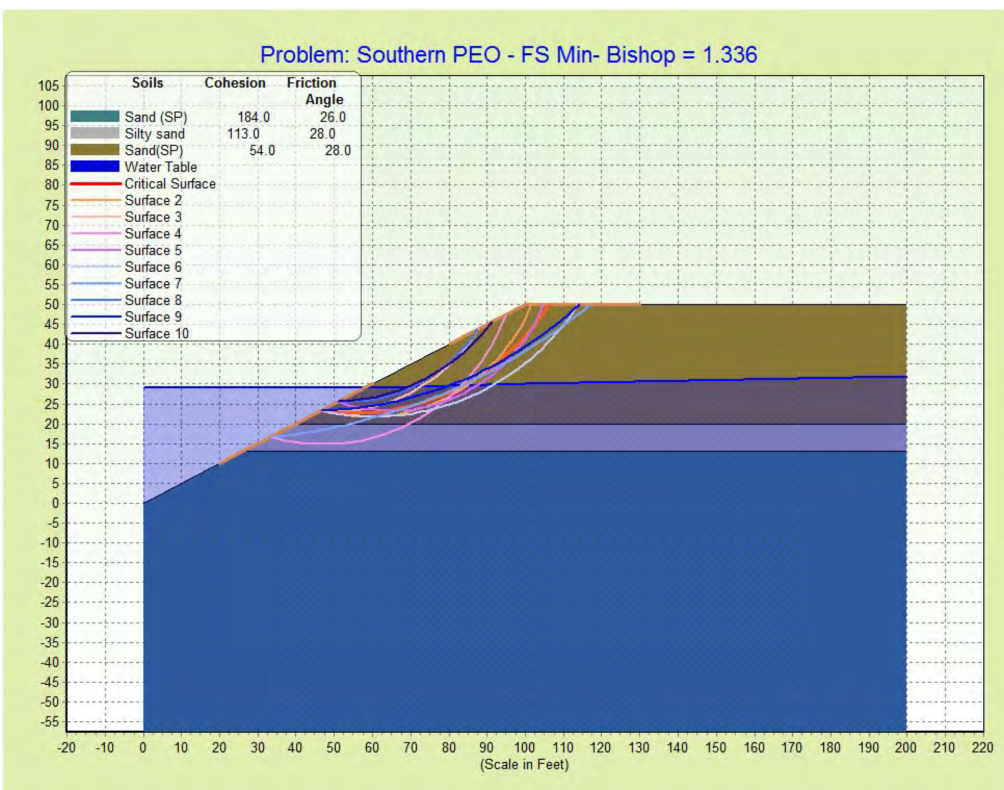
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



result.out
** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	200.00	50.00	1
5	40.00	20.00	200.00	20.00	2
6	26.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1
3	117.0	125.0	184.0	26.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	100.00	30.00
4	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 20.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 80.00 ft.
and X = 130.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.65	23.07
3	50.64	22.88
4	52.64	22.75
5	54.64	22.69

6	56.64	22.69
7	58.63	22.76
8	60.63	22.89
9	62.62	23.09
10	64.60	23.36
11	66.57	23.69
12	68.53	24.09
13	70.48	24.55
14	72.41	25.08
15	74.32	25.67
16	76.21	26.32
17	78.08	27.03
18	79.92	27.81
19	81.74	28.64
20	83.53	29.54
21	85.29	30.49
22	87.01	31.51
23	88.70	32.57
24	90.36	33.70
25	91.97	34.88
26	93.55	36.11
27	95.08	37.39
28	96.58	38.72
29	98.02	40.10
30	99.42	41.53
31	100.78	43.00
32	102.08	44.52
33	103.33	46.08
34	104.53	47.68
35	105.68	49.32
36	106.12	50.00

Circle Center At X = 55.5 ; Y = 83.1 and Radius, 60.5

*** 1.336 ***

Individual data on the 38 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.0	146.5	715.3	723.4	0.0	0.0	0.0	0.0	0.0
2	2.0	433.9	580.1	751.9	0.0	0.0	0.0	0.0	0.0
3	2.0	708.0	442.9	772.1	0.0	0.0	0.0	0.0	0.0
4	2.0	967.4	304.3	784.1	0.0	0.0	0.0	0.0	0.0
5	2.0	1210.9	165.0	787.9	0.0	0.0	0.0	0.0	0.0
6	2.0	1437.5	25.5	783.4	0.0	0.0	0.0	0.0	0.0
7	1.4	1098.5	0.0	529.3	0.0	0.0	0.0	0.0	0.0
8	0.6	536.2	0.0	241.6	0.0	0.0	0.0	0.0	0.0
9	2.0	1811.3	0.0	754.5	0.0	0.0	0.0	0.0	0.0
10	2.0	1968.7	0.0	731.5	0.0	0.0	0.0	0.0	0.0
11	2.0	2106.4	0.0	700.4	0.0	0.0	0.0	0.0	0.0
12	2.0	2223.7	0.0	661.0	0.0	0.0	0.0	0.0	0.0
13	1.9	2320.7	0.0	613.5	0.0	0.0	0.0	0.0	0.0
14	1.9	2397.0	0.0	558.0	0.0	0.0	0.0	0.0	0.0
15	1.9	2452.7	0.0	494.4	0.0	0.0	0.0	0.0	0.0
16	1.9	2488.0	0.0	422.9	0.0	0.0	0.0	0.0	0.0

17	1.9	2503.2	0.0	343.6	0.0	0.0	0.0	0.0	0.0
18	1.8	2498.6	0.0	256.4	0.0	0.0	0.0	0.0	0.0
19	1.8	2474.9	0.0	161.6	0.0	0.0	0.0	0.0	0.0
20	1.8	2432.7	0.0	59.2	0.0	0.0	0.0	0.0	0.0
21	0.1	128.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0
22	1.7	2249.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	1.7	2312.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	1.7	2231.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	1.7	2135.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	1.6	2026.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	1.6	1905.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	1.5	1774.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	1.5	1633.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	1.4	1484.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	1.4	1328.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.6	512.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.8	640.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	1.3	902.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	1.3	653.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	1.2	416.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	1.1	191.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	0.4	16.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.61	22.85
3	50.57	22.46
4	52.55	22.15
5	54.53	21.92
6	56.53	21.78
7	58.53	21.73
8	60.53	21.76
9	62.52	21.88
10	64.51	22.08
11	66.49	22.37
12	68.46	22.74
13	70.40	23.20
14	72.33	23.74
15	74.23	24.36
16	76.10	25.06
17	77.94	25.85
18	79.75	26.71
19	81.52	27.64
20	83.24	28.66
21	84.92	29.74
22	86.55	30.90
23	88.13	32.12
24	89.66	33.42
25	91.13	34.77
26	92.54	36.19
27	93.89	37.67
28	95.17	39.20
29	96.39	40.79
30	97.54	42.43
31	98.61	44.11
32	99.61	45.84
33	100.54	47.62
34	101.39	49.43

35	101.63	50.00

Circle Center At X = 58.8 ; Y = 68.3 and Radius, 46.6

*** 1.340 ***

1

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.66	23.21
3	50.66	23.18
4	52.66	23.25
5	54.66	23.40
6	56.64	23.64
7	58.61	23.97
8	60.57	24.39
9	62.50	24.90
10	64.41	25.50
11	66.29	26.18
12	68.14	26.94
13	69.95	27.79
14	71.72	28.72
15	73.45	29.73
16	75.13	30.82
17	76.76	31.98
18	78.33	33.21
19	79.85	34.52
20	81.30	35.89
21	82.69	37.33
22	84.02	38.82
23	85.28	40.38
24	86.46	41.99
25	87.57	43.65
26	87.69	43.84

Circle Center At X = 50.3 ; Y = 67.3 and Radius, 44.1

*** 1.385 ***

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.33	16.67
2	35.27	16.17
3	37.23	15.75
4	39.20	15.41
5	41.18	15.15

6	43.17	14.96
7	45.17	14.85
8	47.17	14.81
9	49.17	14.86
10	51.16	14.98
11	53.15	15.18
12	55.13	15.45
13	57.10	15.80
14	59.06	16.23
15	60.99	16.74
16	62.91	17.32
17	64.80	17.97
18	66.66	18.70
19	68.49	19.49
20	70.30	20.36
21	72.06	21.30
22	73.79	22.30
23	75.48	23.38
24	77.13	24.51
25	78.73	25.71
26	80.28	26.97
27	81.78	28.29
28	83.23	29.67
29	84.63	31.10
30	85.97	32.59
31	87.25	34.13
32	88.47	35.71
33	89.62	37.34
34	90.72	39.02
35	91.74	40.73
36	92.70	42.49
37	93.59	44.28
38	94.41	46.10
39	94.97	47.49

Circle Center At X = 47.0 ; Y = 66.3 and Radius, 51.5

*** 1.419 ***

1

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.02	24.95
3	54.95	24.44
4	56.91	24.02
5	58.88	23.69
6	60.86	23.45
7	62.86	23.30
8	64.86	23.25
9	66.86	23.29
10	68.85	23.42
11	70.84	23.65
12	72.82	23.97
13	74.77	24.38

14	76.71	24.88
15	78.62	25.47
16	80.50	26.15
17	82.35	26.92
18	84.16	27.77
19	85.93	28.70
20	87.65	29.72
21	89.32	30.82
22	90.94	31.99
23	92.51	33.23
24	94.01	34.55
25	95.45	35.94
26	96.83	37.39
27	98.13	38.91
28	99.37	40.48
29	100.53	42.11
30	101.61	43.79
31	102.61	45.52
32	103.53	47.30
33	104.37	49.11
34	104.73	50.00

Circle Center At X =   65.0 ; Y =   66.1 and Radius,   42.9

*** 1.426 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.63	22.93
3	50.60	22.59
4	52.58	22.31
5	54.57	22.09
6	56.56	21.93
7	58.56	21.84
8	60.56	21.81
9	62.56	21.84
10	64.55	21.93
11	66.55	22.08
12	68.54	22.30
13	70.52	22.57
14	72.49	22.91
15	74.45	23.31
16	76.39	23.77
17	78.33	24.29
18	80.24	24.87
19	82.13	25.51
20	84.01	26.21
21	85.86	26.96
22	87.69	27.78
23	89.49	28.65
24	91.26	29.57
25	93.01	30.55
26	94.72	31.58
27	96.40	32.67

28	98.04	33.81
29	99.65	34.99
30	101.22	36.23
31	102.76	37.52
32	104.25	38.85
33	105.70	40.23
34	107.10	41.65
35	108.47	43.11
36	109.78	44.62
37	111.05	46.17
38	112.27	47.75
39	113.44	49.38
40	113.86	50.00

Circle Center At X =   60.6 ; Y =   86.2 and Radius,   64.4

*** 1.437 ***

1

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.33	16.67
2	35.32	16.86
3	37.31	17.07
4	39.30	17.31
5	41.28	17.57
6	43.26	17.86
7	45.24	18.18
8	47.21	18.52
9	49.17	18.88
10	51.13	19.27
11	53.09	19.69
12	55.04	20.13
13	56.99	20.59
14	58.93	21.08
15	60.86	21.60
16	62.78	22.14
17	64.70	22.70
18	66.62	23.29
19	68.52	23.90
20	70.42	24.54
21	72.30	25.20
22	74.18	25.88
23	76.05	26.59
24	77.91	27.32
25	79.77	28.08
26	81.61	28.86
27	83.44	29.66
28	85.26	30.49
29	87.07	31.33
30	88.87	32.21
31	90.66	33.10
32	92.44	34.02
33	94.20	34.96
34	95.96	35.92

35	97.70	36.91
36	99.42	37.91
37	101.14	38.94
38	102.84	39.99
39	104.53	41.07
40	106.20	42.16
41	107.86	43.28
42	109.51	44.41
43	111.14	45.57
44	112.76	46.75
45	114.36	47.95
46	115.94	49.16
47	117.00	50.00

Circle Center At X =   19.5 ; Y = 173.0 and Radius, 156.9

*** 1.446 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.50
3	55.11	25.55
4	57.11	25.69
5	59.09	25.93
6	61.06	26.26
7	63.02	26.69
8	64.95	27.22
9	66.85	27.83
10	68.72	28.54
11	70.55	29.34
12	72.35	30.22
13	74.10	31.19
14	75.79	32.25
15	77.44	33.39
16	79.03	34.60
17	80.56	35.89
18	82.02	37.25
19	83.42	38.68
20	84.74	40.18
21	86.00	41.74
22	87.17	43.36
23	87.39	43.69

Circle Center At X =   53.2 ; Y =   66.8 and Radius,   41.3

*** 1.451 ***

1

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.67	23.40
3	50.66	23.51
4	52.66	23.65
5	54.65	23.83
6	56.64	24.05
7	58.62	24.30
8	60.60	24.60
9	62.57	24.93
10	64.54	25.30
11	66.50	25.70
12	68.45	26.15
13	70.39	26.63
14	72.32	27.14
15	74.24	27.70
16	76.15	28.29
17	78.05	28.91
18	79.94	29.58
19	81.81	30.28
20	83.67	31.01
21	85.52	31.78
22	87.35	32.58
23	89.17	33.42
24	90.97	34.29
25	92.75	35.20
26	94.51	36.14
27	96.26	37.12
28	97.99	38.12
29	99.70	39.16
30	101.39	40.23
31	103.05	41.34
32	104.70	42.47
33	106.32	43.64
34	107.93	44.84
35	109.50	46.07
36	111.06	47.32
37	112.59	48.61
38	114.10	49.93
39	114.18	50.00

Circle Center At X = 44.2 ; Y = 128.5 and Radius, 105.2

*** 1.454 ***

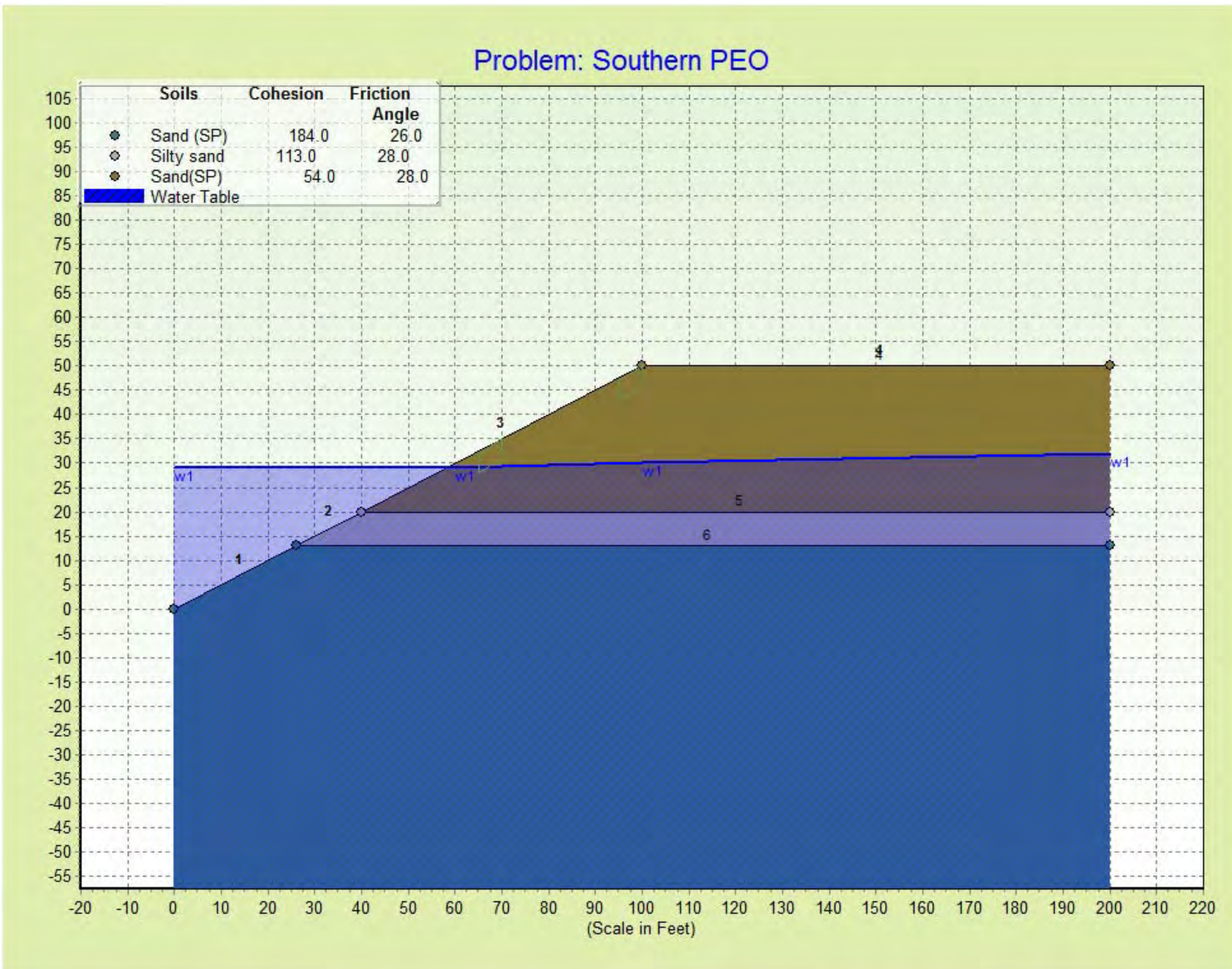
Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.65
3	55.10	25.82
4	57.09	26.06
5	59.06	26.38

```
    6          61.02       26.77
    7          62.97       27.23
    8          64.90       27.77
    9          66.80       28.38
   10          68.68       29.06
   11          70.53       29.81
   12          72.36       30.63
   13          74.15       31.52
   14          75.91       32.47
   15          77.63       33.49
   16          79.31       34.58
   17          80.95       35.72
   18          82.54       36.93
   19          84.09       38.20
   20          85.59       39.52
   21          87.04       40.90
   22          88.44       42.33
   23          89.78       43.81
   24          91.07       45.34
   25          91.30       45.65

Circle Center At X =   49.6 ; Y =   78.8  and Radius,   53.2


      ***     1.455   ***



1

           Y            A     X     I     S           F     T


           0.00     25.00     50.00     75.00    100.00    125.00

X      0.00 *---------+-W-------+---------+---------+---------+
            -
            -
            -
            -
            -   .
     25.00 + ...*
            - .....
            -.....44
            -.....47.
            ......47*
            ......47.1
A     50.00 ......4.715
            ......4.715.
            ......4.7130W
            .......4.138.
            .......441130.
            ........42138..
X     75.00 .........41133..
            ..........21933..
            -.........611.333.
            -..........5214.033
            -...........6114444.
            - ...........6512244.
I    100.00 +  .........W.671112*
            -   ...........667111
            -    ............66..
            -     ...........666
```

```
                 -       ............7
                 -          ...........
S     125.00 +             .........
                 -                  ....
                 -
                 -
                 -
                 -
      150.00 +
                 -
                 -
                 -
                 -
                 -
F     175.00 +
                 -
                 -
                 -
                 -
                 -
T     200.00 +     *   *     W       *
```

================== DATA SUMMARY ====================



Profile Data

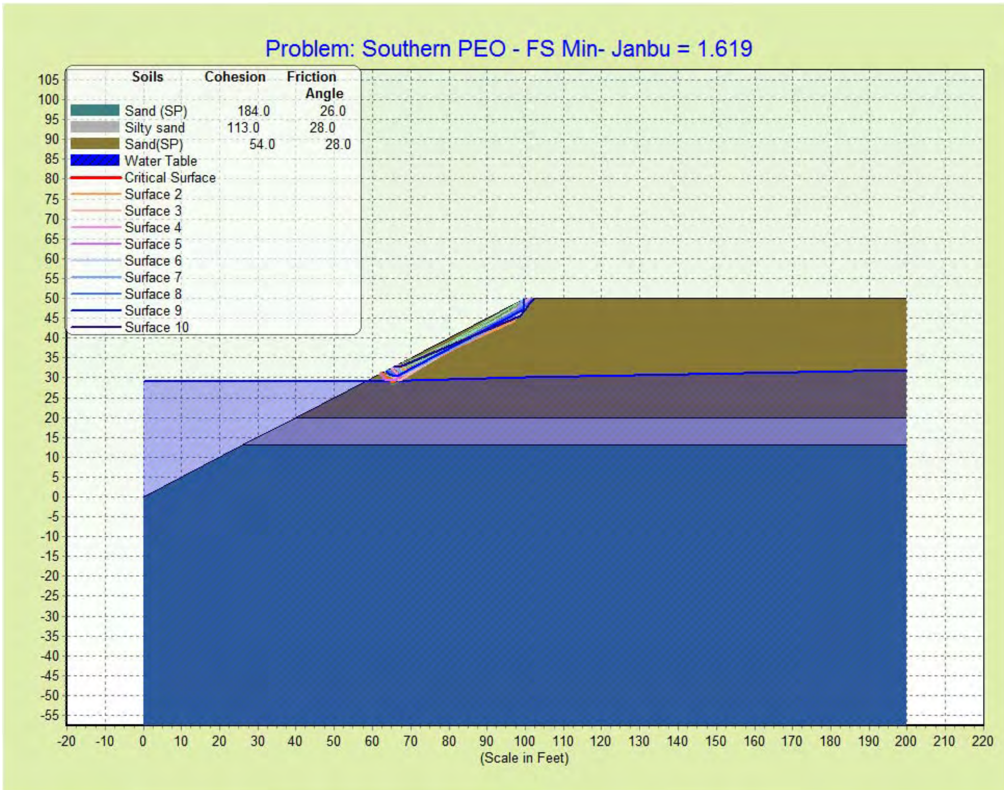
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	200	50	1
5	40	20	200	20	2
6	26	13	200	13	3

Soil Properties

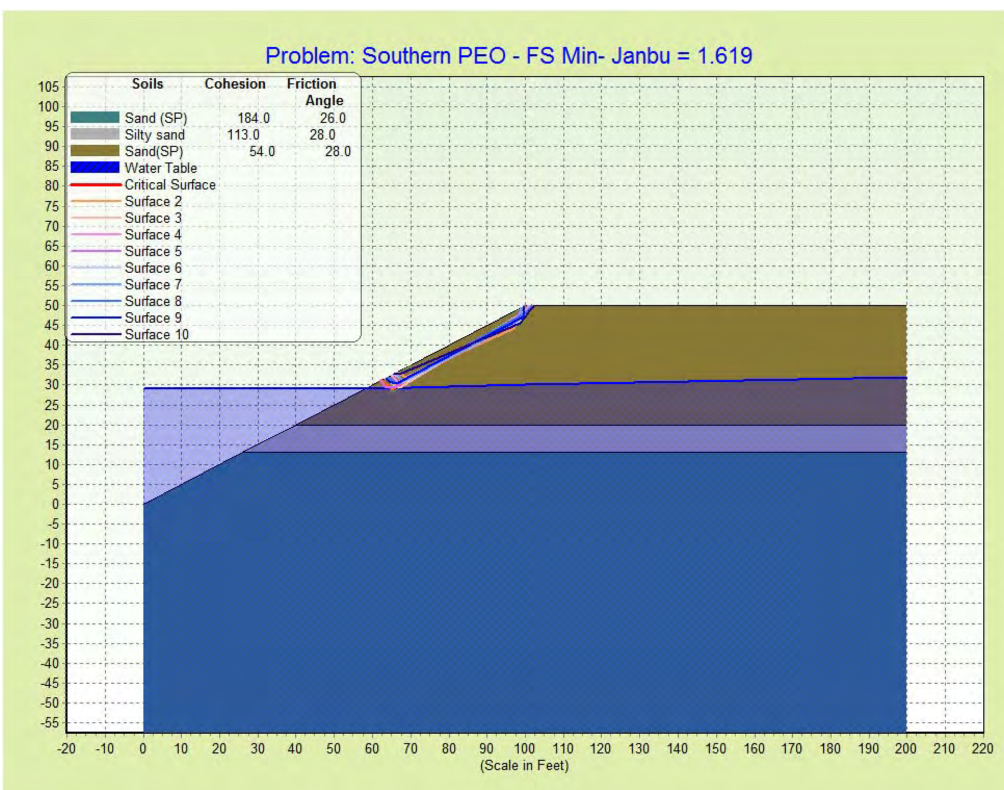
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



result.out
** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	200.00	50.00	1
5	40.00	20.00	200.00	20.00	2
6	26.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1
3	117.0	125.0	184.0	26.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	100.00	30.00
4	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

20 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 2.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	65.00	30.00	70.00	33.00	4.00
2	95.00	45.00	100.00	48.00	4.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	62.27	31.14
2	63.54	30.01
3	65.26	28.99
4	98.43	46.02
5	99.56	47.67
6	100.97	49.09
7	101.64	50.00

*** 1.619 ***

Individual data on the 9 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.3	124.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5	427.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.2	90.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0
4	0.3	117.3	0.0	1.4	0.0	0.0	0.0	0.0	0.0
5	32.9	12461.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.1	332.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.4	97.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.7	33.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.44	33.22
2	67.07	32.95
3	68.75	31.87
4	97.06	44.28
5	98.02	46.04
6	99.09	47.73
7	100.35	49.28
8	100.92	50.00

*** 1.624 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.34	31.67
2	63.82	31.42
3	65.33	30.10
4	67.18	29.35
5	99.79	48.34
6	101.20	49.75
7	101.33	50.00

*** 1.702 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	64.77	32.39
2	65.71	31.80
3	67.18	30.44
4	98.78	46.32
5	99.48	48.19
6	100.88	49.61
7	100.92	50.00

***   1.704   ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	61.95	30.97
2	62.12	30.82
3	63.54	29.41
4	65.54	29.36
5	97.59	46.85
6	98.65	48.54
7	99.00	49.50

***   1.708   ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.54	32.77
2	66.45	32.08
3	67.87	30.67
4	99.37	46.73
5	100.78	48.15
6	101.57	49.99
7	101.59	50.00

***   1.710   ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.63	32.82
2	66.53	32.38
3	67.95	30.96
4	96.20	44.70
5	97.61	46.12
6	98.74	47.77
7	98.88	49.44

*** 1.712 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.82	31.91
2	64.77	31.40
3	66.42	30.27
4	99.78	47.79
5	101.07	49.32
6	101.71	50.00

*** 1.729 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.44	31.72
2	64.43	30.94
3	66.34	30.35
4	99.34	47.08
5	99.69	49.05
6	99.74	49.87

*** 1.734 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.36	32.68
2	67.01	32.61
3	98.73	45.67
4	99.99	47.23
5	101.21	48.81
6	102.37	50.00

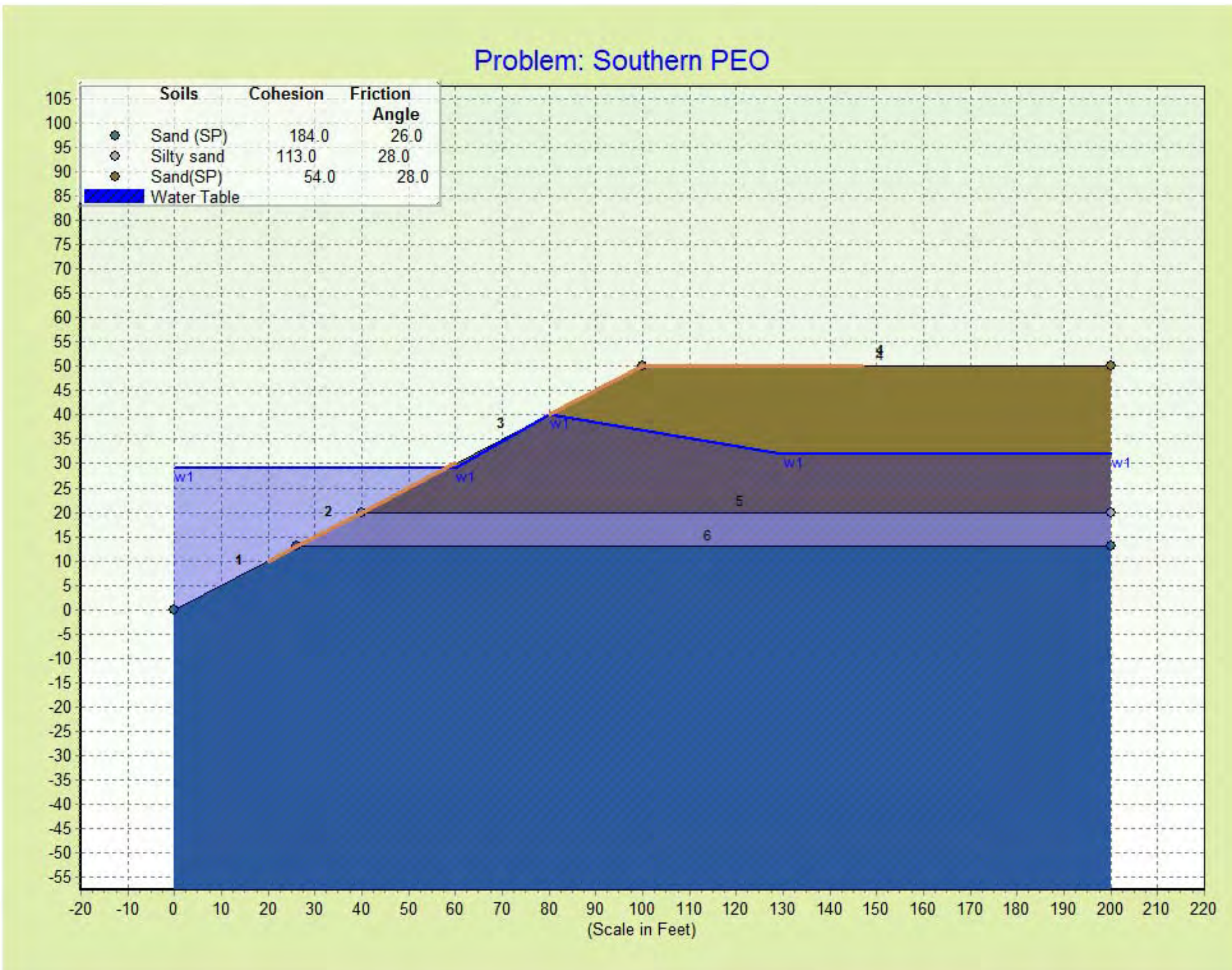
***   1.742   ***

```
1
           Y            A     X     I     S            F     T

           0.00     25.00     50.00     75.00    100.00    125.00

X      0.00 *---------+-W-------+---------+---------+---------+
            -
            -
            -
            -
            -
      25.00 +    *
            -
            -
            -
            -       *
            -
A     50.00 +
            -
            -           W
            -           13
            -           12.
            -           .2
X     75.00 +
            -
            -
            -
            -
            -                 25
I    100.00 +           W     11*
            -                   0
            -
            -
            -
            -
S    125.00 +
            -
            -
            -
            -
            -
     150.00 +
            -
            -
            -
            -
```

```
                   -
F    175.00 +
                   -
                   -
                   -
                   -
                   -
T    200.00 +     *  *    W      *
```

Appendix C.2
Existing Riverbank, Rapid Drawdown Condition

================== DATA SUMMARY ====================



Profile Data

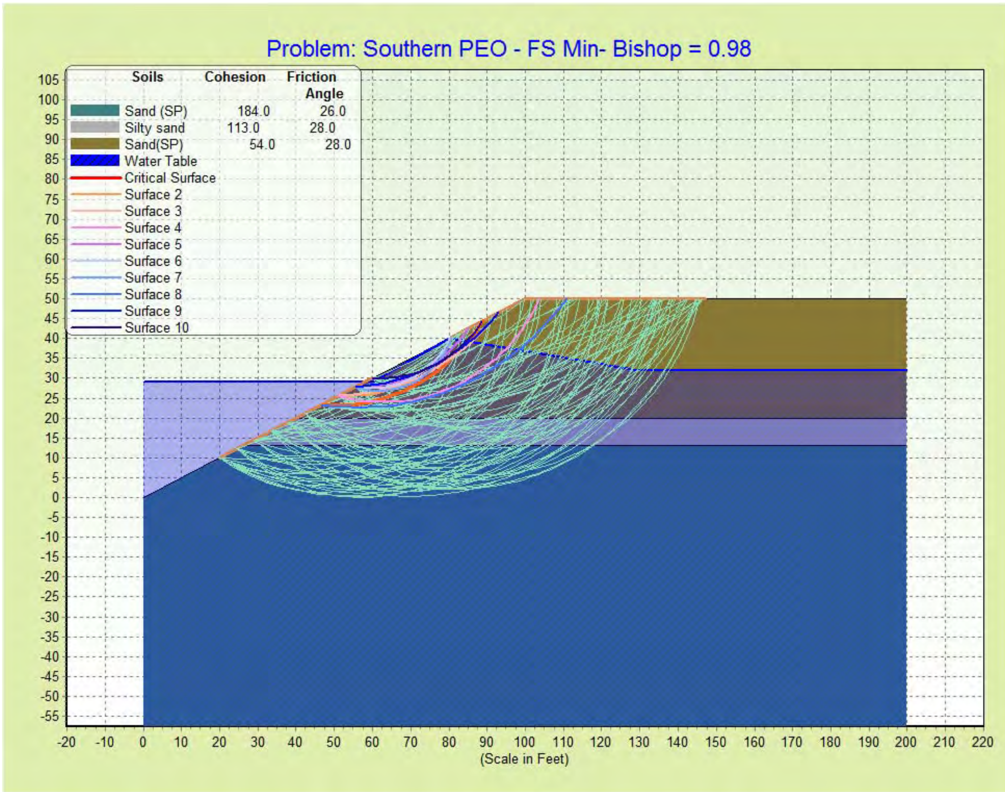
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	200	50	1
5	40	20	200	20	2
6	26	13	200	13	3

Soil Properties

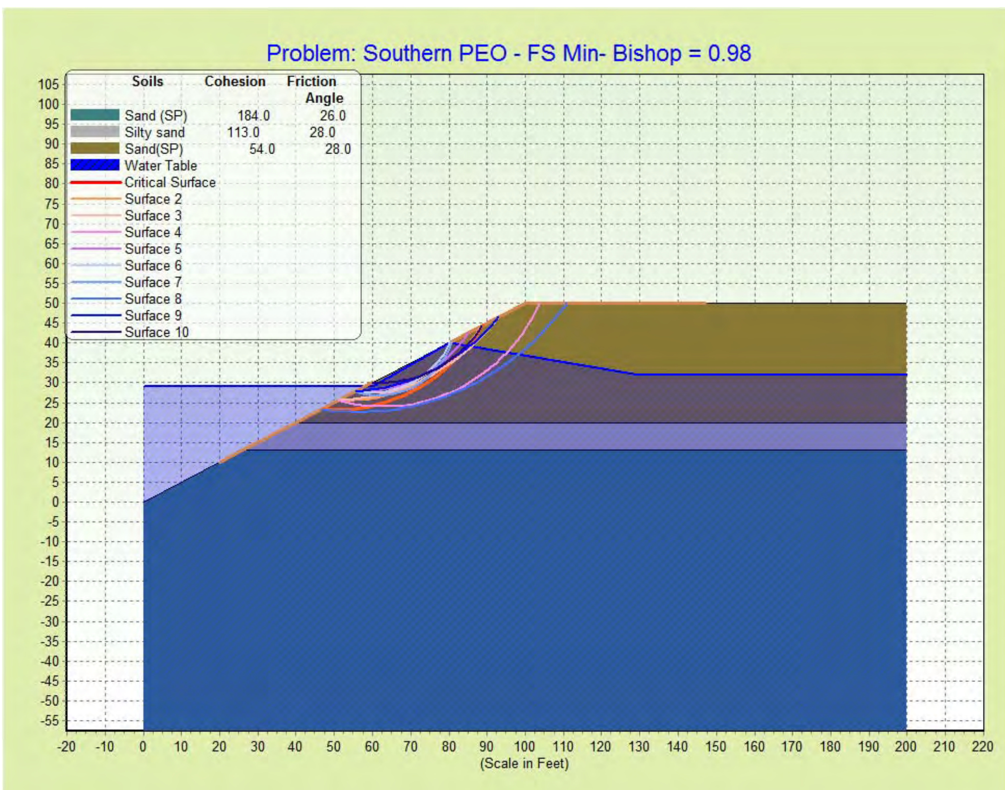
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



result.out
** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	200.00	50.00	1
5	40.00	20.00	200.00	20.00	2
6	26.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1
3	117.0	125.0	184.0	26.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	80.00	40.00
4	130.00	32.00
5	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 20.00 ft. and X = 60.00 ft.

Each Surface Terminates Between X = 80.00 ft. and X = 147.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.66	23.21
3	50.66	23.18
4	52.66	23.24

5	54.66	23.38
6	56.64	23.61
7	58.62	23.93
8	60.58	24.34
9	62.52	24.83
10	64.43	25.41
11	66.32	26.07
12	68.18	26.81
13	70.00	27.63
14	71.78	28.54
15	73.53	29.52
16	75.22	30.57
17	76.87	31.71
18	78.47	32.91
19	80.02	34.18
20	81.50	35.52
21	82.93	36.92
22	84.29	38.38
23	85.59	39.90
24	86.82	41.48
25	87.98	43.11
26	88.82	44.41

Circle Center At X = 50.4 ; Y = 68.6 and Radius, 45.4

*** 0.980 ***

Individual data on the 28 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.0	131.7	719.7	714.6	0.0	0.0	0.0	0.0	0.0
2	2.0	385.5	581.5	724.1	0.0	0.0	0.0	0.0	0.0
3	2.0	618.4	441.9	722.6	0.0	0.0	0.0	0.0	0.0
4	2.0	828.4	302.0	710.1	0.0	0.0	0.0	0.0	0.0
5	2.0	1014.2	162.8	686.6	0.0	0.0	0.0	0.0	0.0
6	2.0	1174.5	25.4	652.2	0.0	0.0	0.0	0.0	0.0
7	1.4	903.1	0.0	433.5	0.0	0.0	0.0	0.0	0.0
8	0.6	392.7	0.0	158.5	0.0	0.0	0.0	0.0	0.0
9	1.9	1394.7	0.0	580.8	0.0	0.0	0.0	0.0	0.0
10	1.9	1475.3	0.0	638.8	0.0	0.0	0.0	0.0	0.0
11	1.9	1528.9	0.0	685.9	0.0	0.0	0.0	0.0	0.0
12	1.9	1556.1	0.0	722.1	0.0	0.0	0.0	0.0	0.0
13	1.8	1557.4	0.0	747.4	0.0	0.0	0.0	0.0	0.0
14	1.8	1533.9	0.0	761.5	0.0	0.0	0.0	0.0	0.0
15	1.7	1486.9	0.0	764.6	0.0	0.0	0.0	0.0	0.0
16	1.7	1418.0	0.0	756.7	0.0	0.0	0.0	0.0	0.0
17	1.6	1329.1	0.0	737.6	0.0	0.0	0.0	0.0	0.0
18	1.6	1222.2	0.0	707.5	0.0	0.0	0.0	0.0	0.0
19	1.5	1088.8	0.0	659.8	0.0	0.0	0.0	0.0	0.0
20	0.0	11.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0
21	1.5	964.7	0.0	620.1	0.0	0.0	0.0	0.0	0.0
22	1.4	808.2	0.0	422.6	0.0	0.0	0.0	0.0	0.0
23	1.4	645.6	0.0	218.5	0.0	0.0	0.0	0.0	0.0
24	0.7	276.2	0.0	30.9	0.0	0.0	0.0	0.0	0.0
25	0.6	205.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

26	1.2	328.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	1.2	180.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.8	40.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.50
3	55.11	25.55
4	57.11	25.68
5	59.09	25.91
6	61.07	26.24
7	63.02	26.65
8	64.96	27.16
9	66.87	27.76
10	68.74	28.45
11	70.59	29.22
12	72.39	30.08
13	74.15	31.03
14	75.87	32.06
15	77.54	33.16
16	79.15	34.35
17	80.70	35.61
18	82.19	36.94
19	83.62	38.34
20	84.98	39.80
21	86.28	41.33
22	87.49	42.92
23	88.38	44.19

Circle Center At X = 53.2 ; Y = 68.0 and Radius, 42.4

*** 0.987 ***

1

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.65
3	55.10	25.81
4	57.09	26.05
5	59.06	26.36
6	61.03	26.74
7	62.98	27.19
8	64.91	27.71
9	66.82	28.29
10	68.71	28.95
11	70.57	29.68
12	72.41	30.47
13	74.22	31.32
14	75.99	32.24

15	77.73	33.23
16	79.44	34.27
17	81.11	35.38
18	82.73	36.55
19	84.31	37.77
20	85.85	39.05
21	87.34	40.38
22	88.78	41.77
23	90.17	43.21
24	91.51	44.69
25	92.79	46.23
26	93.01	46.50

Circle Center At X = 49.5 ; Y = 81.1 and Radius, 55.6

*** 1.010 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.05	25.08
3	55.01	24.68
4	56.99	24.38
5	58.98	24.16
6	60.98	24.03
7	62.97	23.99
8	64.97	24.04
9	66.97	24.18
10	68.96	24.40
11	70.93	24.72
12	72.89	25.12
13	74.83	25.61
14	76.75	26.18
15	78.64	26.83
16	80.50	27.57
17	82.32	28.40
18	84.10	29.30
19	85.85	30.28
20	87.55	31.33
21	89.20	32.46
22	90.79	33.66
23	92.34	34.94
24	93.82	36.27
25	95.25	37.68
26	96.61	39.14
27	97.91	40.67
28	99.13	42.25
29	100.29	43.88
30	101.37	45.56
31	102.37	47.29
32	103.30	49.06
33	103.74	50.00

Circle Center At X = 62.9 ; Y = 69.1 and Radius, 45.1

*** 1.040 ***

1

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.56	27.76
3	59.55	27.86
4	61.54	28.08
5	63.51	28.41
6	65.46	28.86
7	67.38	29.42
8	69.27	30.09
9	71.11	30.87
10	72.90	31.76
11	74.64	32.75
12	76.32	33.83
13	77.93	35.02
14	79.47	36.29
15	80.94	37.66
16	82.32	39.10
17	83.61	40.63
18	84.82	42.22
19	85.00	42.50

Circle Center At X = 56.8 ; Y = 62.1 and Radius, 34.3

*** 1.044 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.54	27.52
3	59.54	27.42
4	61.54	27.50
5	63.52	27.76
6	65.47	28.18
7	67.39	28.76
8	69.24	29.51
9	71.03	30.41
10	72.73	31.47
11	74.33	32.66
12	75.83	33.99
13	77.20	35.44
14	78.45	37.00
15	79.56	38.67
16	80.40	40.20

Circle Center At X = 59.6 ; Y = 50.7 and Radius, 23.3

*** 1.070 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.49	27.27
3	59.46	26.95
4	61.46	26.83
5	63.46	26.91
6	65.44	27.18
7	67.38	27.65
8	69.27	28.31
9	71.09	29.15
10	72.81	30.17
11	74.42	31.35
12	75.91	32.69
13	77.26	34.17
14	78.45	35.77
15	79.48	37.49
16	80.34	39.29
17	80.72	40.36

Circle Center At X = 61.7 ; Y = 47.0 and Radius, 20.2

*** 1.070 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.65	23.07
3	50.64	22.87
4	52.63	22.73
5	54.63	22.64
6	56.63	22.62
7	58.63	22.65
8	60.63	22.75
9	62.62	22.90
10	64.61	23.11
11	66.59	23.38
12	68.57	23.71
13	70.53	24.10
14	72.48	24.55
15	74.42	25.05

16	76.34	25.61
17	78.24	26.23
18	80.12	26.90
19	81.98	27.63
20	83.82	28.41
21	85.64	29.25
22	87.43	30.14
23	89.19	31.08
24	90.93	32.08
25	92.63	33.12
26	94.31	34.22
27	95.95	35.36
28	97.55	36.56
29	99.12	37.80
30	100.65	39.08
31	102.15	40.41
32	103.60	41.79
33	105.01	43.20
34	106.38	44.66
35	107.70	46.16
36	108.99	47.70
37	110.22	49.27
38	110.76	50.00

Circle Center At X = 56.5 ; Y = 90.1 and Radius, 67.5

*** 1.076 ***

1

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.55	27.94
3	59.54	28.18
4	61.51	28.49
5	63.47	28.87
6	65.42	29.33
7	67.35	29.86
8	69.26	30.46
9	71.14	31.13
10	73.00	31.87
11	74.83	32.68
12	76.62	33.56
13	78.39	34.51
14	80.11	35.51
15	81.80	36.59
16	83.45	37.72
17	85.05	38.92
18	86.61	40.17
19	88.12	41.49
20	89.58	42.85
21	90.98	44.28
22	92.34	45.75
23	92.96	46.48

Circle Center At X =   52.2 ; Y =   81.3 and Radius,   53.6

*** 1.077 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.00	30.00
2	62.00	29.94
3	64.00	30.00
4	65.99	30.19
5	67.97	30.50
6	69.92	30.93
7	71.84	31.49
8	73.72	32.17
9	75.56	32.96
10	77.34	33.87
11	79.06	34.88
12	80.72	36.00
13	82.30	37.23
14	83.80	38.55
15	85.22	39.96
16	86.54	41.46
17	87.77	43.04
18	88.65	44.33

Circle Center At X =   62.0 ; Y =   61.8 and Radius,   31.9

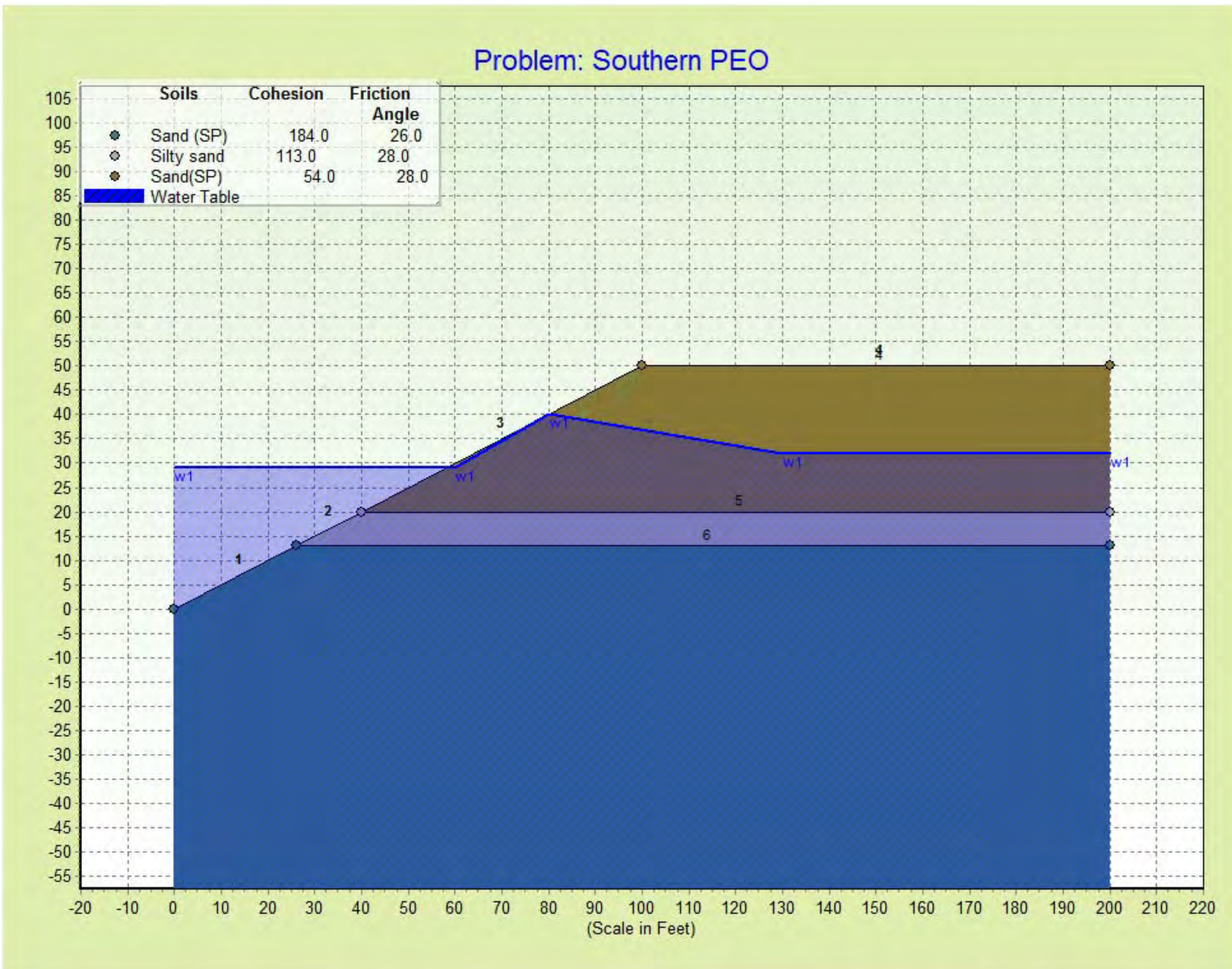
*** 1.092 ***

1

```
           Y          A     X     I     S          F     T

           0.00     25.00     50.00     75.00    100.00    125.00

 X      0.00 *---------+-W-------+---------+---------+---------+
             -
             -
             -
             -
             -   .
       25.00 + ...*
             - .....
             -.......
             -........
             -.......*
             .........1
 A     50.00 .........12
             .........125
             .........113W
             .........8129.
```

```
                 .........8113.
                 ..........4125.
X        75.00 ..........4.115.
                 ..........84.115W
                 -..........44.1125
                 -...........44..111
                 -............44..333
                 -.............844...
I       100.00 + .............8844.*
               - ..............88.44
               -  ...............888
               -   ...............8
               -    ...............
               -     ..............
S       125.00 +      .............
               -       .....W.......
               -         ...........
               -           .........
               -              ......
               -                 ...
        150.00 +
               -
               -
               -
               -
               -
F       175.00 +
               -
               -
               -
               -
               -
T       200.00 +    *  *    W      *
```

================== DATA SUMMARY ====================



Profile Data

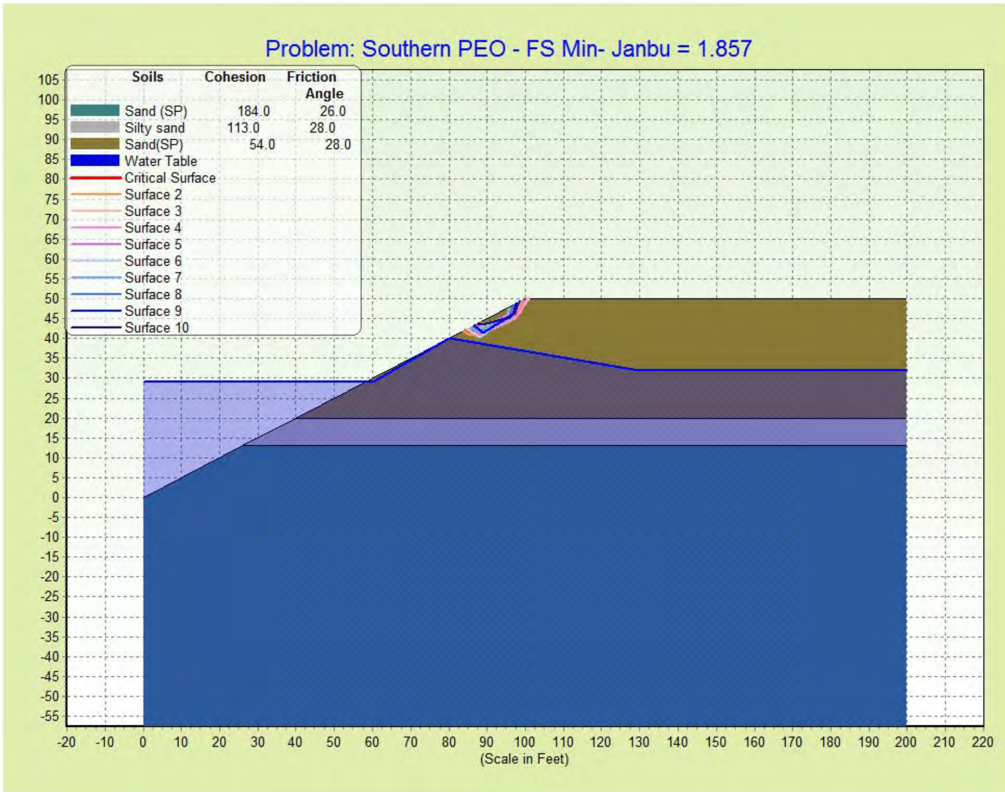
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	200	50	1
5	40	20	200	20	2
6	26	13	200	13	3

Soil Properties

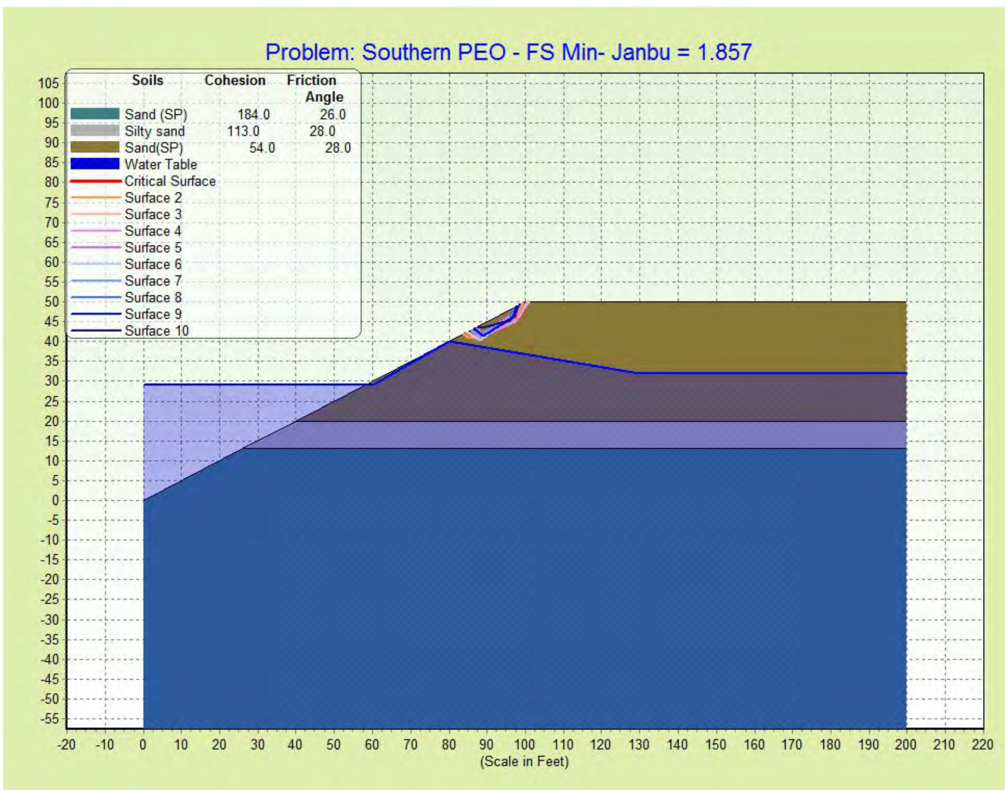
Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



result.out
** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	200.00	50.00	1
5	40.00	20.00	200.00	20.00	2
6	26.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1
3	117.0	125.0	184.0	26.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	80.00	40.00
4	130.00	32.00
5	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

20 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is   2.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	87.00	41.00	90.00	43.00	3.00
2	95.00	45.00	98.00	47.00	3.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.17	42.09
2	85.18	41.19
3	87.15	40.83
4	96.72	45.36
5	98.13	46.78
6	99.34	48.37
7	100.75	49.79

8	100.84	50.00

*** 1.857 ***

Individual data on the 8 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	78.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0	452.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	9.6	3054.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.4	414.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.2	241.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.7	83.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.7	49.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	83.62	41.81
2	85.10	41.02
3	87.10	40.89
4	96.31	44.40
5	97.06	46.26
6	98.37	47.76
7	99.32	49.53
8	99.58	49.79

*** 1.934 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.78	42.89
2	86.00	42.79
3	87.47	41.42
4	97.24	45.15
5	98.59	46.63
6	99.61	48.35
7	100.94	49.85
8	101.05	50.00

*** 1.974 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.21	43.60
2	88.10	42.79
3	89.77	41.68
4	97.74	45.47
5	98.72	47.22
6	99.86	48.86
7	100.53	50.00

***   2.069   ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.89	42.45
2	86.12	41.58
3	88.11	41.47
4	96.66	47.23
5	97.80	48.88
6	97.84	48.92

***   2.136   ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.78	42.39
2	84.79	42.39
3	86.48	41.32
4	88.24	40.36
5	96.56	46.64
6	97.80	48.21
7	98.34	49.17

***   2.149   ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.78	42.89
2	87.08	41.64
3	96.44	45.28
4	97.04	47.19
5	98.44	48.62
6	98.73	49.37

*** 2.264 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.53	43.27
2	87.53	42.40
3	89.38	41.64
4	95.92	45.81
5	96.59	47.70
6	97.77	48.88

*** 2.299 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.49	43.24
2	87.36	42.64
3	88.82	41.27
4	97.21	46.41
5	97.89	48.29
6	98.70	49.35

*** 2.334 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.42	43.71
2	88.69	43.46
3	95.80	45.19
4	97.06	46.75
5	97.65	48.66
6	97.87	48.93

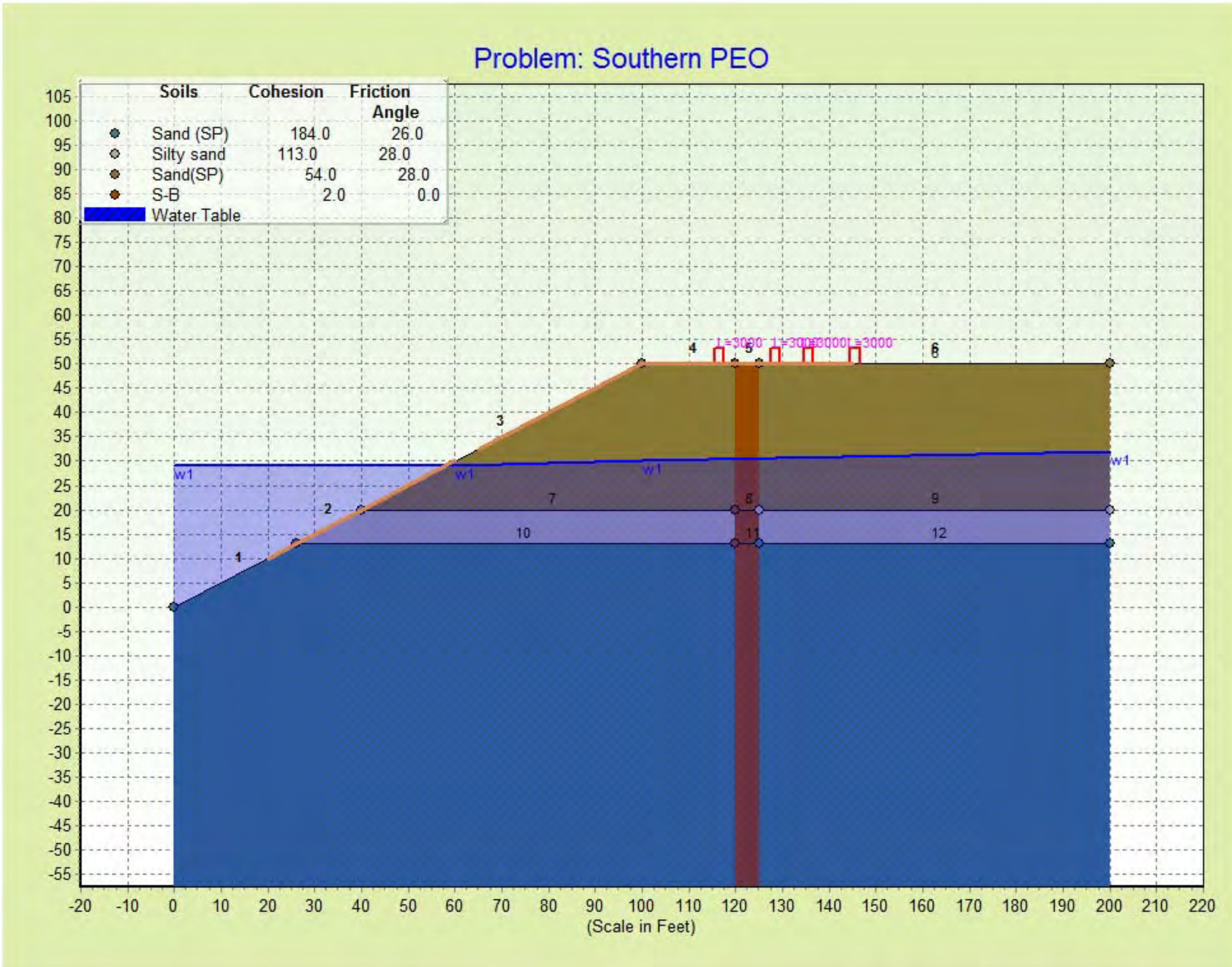
*** 2.340 ***

```
1

                     Y            A     X     I     S            F     T


                     0.00     25.00     50.00     75.00   100.00    125.00

          X      0.00 *---------+-W-------+---------+---------+---------+
                      -
                      -
                      -
                      -
                      -
                25.00 +    *
                      -
                      -
                      -
                      -       *
                      -
          A     50.00 +
                      -
                      -           W
                      -
                      -
                      -
          X     75.00 +
                      -               W
                      -               11
                      -               13.
                      -                4
                      -                 125
          I    100.00 +                  1*
                      -
                      -
                      -
                      -
                      -
          S    125.00 +
                      -            W
                      -
                      -
                      -
                      -
               150.00 +
                      -
                      -
                      -
                      -
```

```
                -
F    175.00 +
                -
                -
                -
                -
                -
T    200.00 +     *  *    W      *
```

Appendix C.3
During Construction, Normal Groundwater Condition

================== DATA SUMMARY ====================



Profile Data

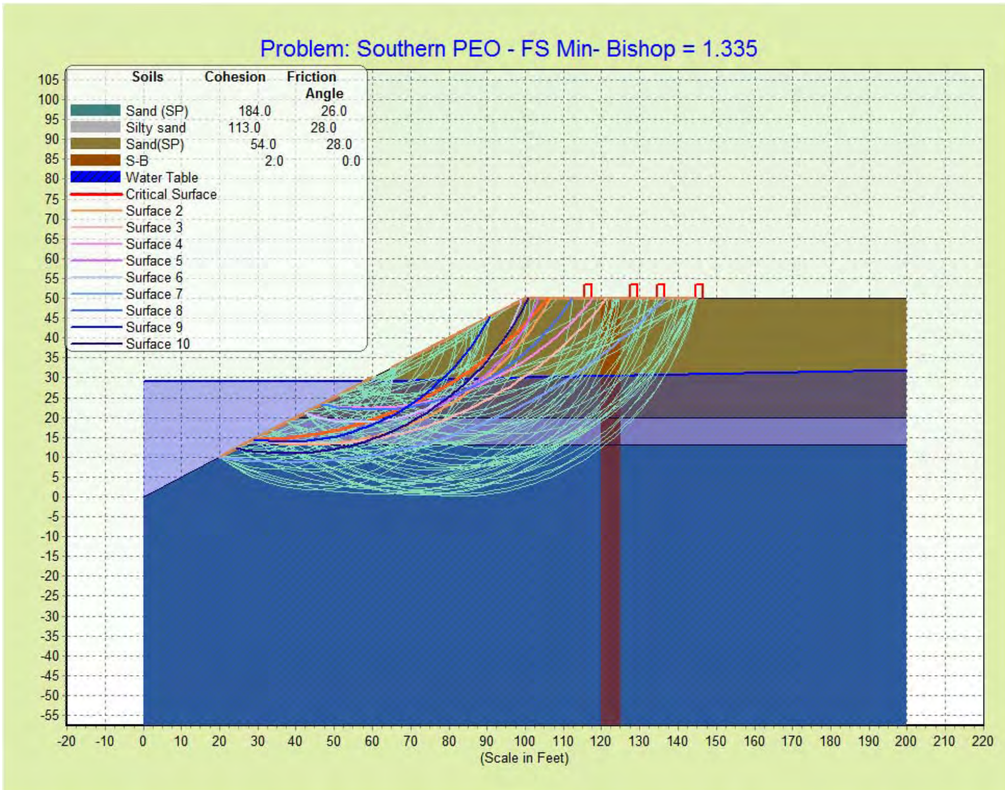
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

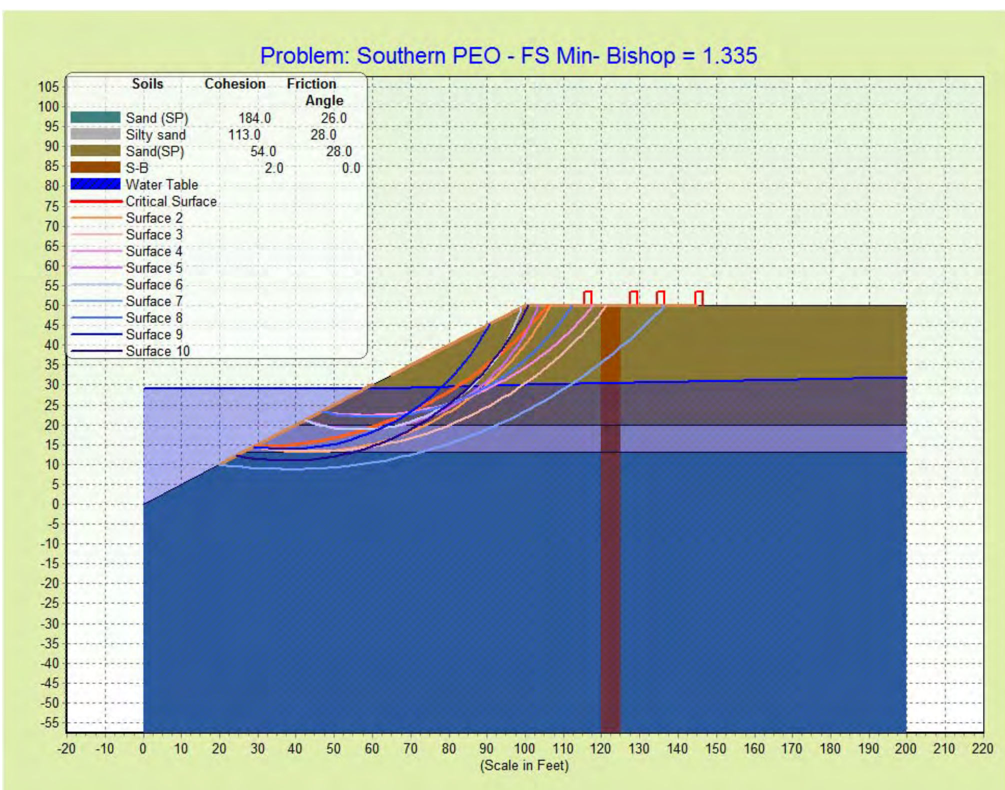
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	100.00	30.00
4	200.00	32.00

1

BOUNDARY LOAD(S)

4 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	115.50	117.50	3000.0	0.0
2	127.50	129.50	3000.0	0.0
3	134.50	136.50	3000.0	0.0
4	144.50	146.50	3000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 20.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 65.00 ft.
and X = 145.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.89	14.44
2	30.89	14.47
3	32.89	14.53
4	34.89	14.64
5	36.88	14.78
6	38.87	14.96
7	40.86	15.18
8	42.84	15.44
9	44.82	15.74
10	46.79	16.08
11	48.76	16.45
12	50.71	16.87
13	52.66	17.32
14	54.60	17.81
15	56.53	18.34
16	58.45	18.91
17	60.35	19.51
18	62.25	20.15
19	64.13	20.83
20	66.00	21.54
21	67.85	22.29
22	69.69	23.08
23	71.51	23.90
24	73.32	24.76
25	75.11	25.65
26	76.88	26.58
27	78.63	27.55
28	80.37	28.54
29	82.08	29.57
30	83.77	30.64
31	85.45	31.74
32	87.10	32.87
33	88.72	34.03
34	90.33	35.22
35	91.91	36.45
36	93.47	37.70
37	95.00	38.99
38	96.51	40.30
39	97.99	41.65
40	99.44	43.02
41	100.87	44.42

42	102.27	45.85
43	103.64	47.31
44	104.98	48.79
45	106.03	50.00

Circle Center At X = 28.6 ; Y = 116.5 and Radius, 102.1

*** 1.335 ***

Individual data on the 49 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.0	112.1	1961.0	1814.9	0.0	0.0	0.0	0.0	0.0
2	2.0	331.5	1820.7	1809.3	0.0	0.0	0.0	0.0	0.0
3	2.0	541.4	1680.0	1798.8	0.0	0.0	0.0	0.0	0.0
4	2.0	741.5	1539.1	1783.5	0.0	0.0	0.0	0.0	0.0
5	2.0	931.4	1398.1	1763.2	0.0	0.0	0.0	0.0	0.0
6	1.1	608.7	730.4	989.6	0.0	0.0	0.0	0.0	0.0
7	0.9	502.8	527.0	748.5	0.0	0.0	0.0	0.0	0.0
8	2.0	1285.5	1117.1	1708.1	0.0	0.0	0.0	0.0	0.0
9	2.0	1449.5	977.4	1673.3	0.0	0.0	0.0	0.0	0.0
10	2.0	1602.6	838.5	1633.6	0.0	0.0	0.0	0.0	0.0
11	2.0	1744.5	700.7	1589.1	0.0	0.0	0.0	0.0	0.0
12	2.0	1875.1	564.1	1539.9	0.0	0.0	0.0	0.0	0.0
13	1.9	1994.3	429.0	1485.8	0.0	0.0	0.0	0.0	0.0
14	1.9	2102.1	295.5	1427.0	0.0	0.0	0.0	0.0	0.0
15	1.9	2198.4	163.9	1363.4	0.0	0.0	0.0	0.0	0.0
16	1.9	2283.2	34.2	1295.1	0.0	0.0	0.0	0.0	0.0
17	1.6	1905.9	0.0	1000.8	0.0	0.0	0.0	0.0	0.0
18	0.4	441.2	0.0	221.3	0.0	0.0	0.0	0.0	0.0
19	1.5	1832.4	0.0	887.0	0.0	0.0	0.0	0.0	0.0
20	0.4	564.3	0.0	261.2	0.0	0.0	0.0	0.0	0.0
21	1.9	2432.9	0.0	1071.9	0.0	0.0	0.0	0.0	0.0
22	1.9	2456.9	0.0	990.9	0.0	0.0	0.0	0.0	0.0
23	1.9	2469.8	0.0	905.3	0.0	0.0	0.0	0.0	0.0
24	1.8	2471.9	0.0	815.1	0.0	0.0	0.0	0.0	0.0
25	1.8	2463.4	0.0	720.4	0.0	0.0	0.0	0.0	0.0
26	1.8	2444.4	0.0	621.2	0.0	0.0	0.0	0.0	0.0
27	1.8	2415.4	0.0	517.5	0.0	0.0	0.0	0.0	0.0
28	1.8	2376.4	0.0	409.4	0.0	0.0	0.0	0.0	0.0
29	1.8	2327.9	0.0	296.9	0.0	0.0	0.0	0.0	0.0
30	1.7	2270.2	0.0	180.1	0.0	0.0	0.0	0.0	0.0
31	1.7	2155.5	0.0	58.9	0.0	0.0	0.0	0.0	0.0
32	0.0	48.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	1.7	2134.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	1.7	2063.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	1.7	1984.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	1.6	1898.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	1.6	1806.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	1.6	1707.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	1.6	1602.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	1.5	1491.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	1.5	1376.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	1.5	1256.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	1.5	1133.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

44	0.6	408.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.9	577.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	1.4	755.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	1.4	520.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	1.3	290.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	1.1	70.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.89	14.44
2	30.86	14.09
3	32.84	13.79
4	34.82	13.54
5	36.81	13.35
6	38.81	13.21
7	40.80	13.13
8	42.80	13.10
9	44.80	13.12
10	46.80	13.20
11	48.80	13.34
12	50.79	13.53
13	52.77	13.77
14	54.75	14.06
15	56.72	14.41
16	58.68	14.81
17	60.63	15.27
18	62.56	15.78
19	64.48	16.34
20	66.39	16.95
21	68.27	17.62
22	70.14	18.33
23	71.99	19.10
24	73.81	19.91
25	75.62	20.78
26	77.40	21.69
27	79.15	22.65
28	80.88	23.66
29	82.58	24.72
30	84.24	25.82
31	85.88	26.97
32	87.49	28.16
33	89.06	29.39
34	90.60	30.67
35	92.11	31.98
36	93.58	33.34
37	95.01	34.74
38	96.40	36.17
39	97.75	37.65
40	99.07	39.16
41	100.34	40.70
42	101.57	42.28
43	102.75	43.89
44	103.89	45.53
45	104.99	47.21
46	106.04	48.91
47	106.67	50.00

Circle Center At X = 42.9 ; Y = 86.7 and Radius, 73.6

*** 1.344 ***

1

Failure Surface Specified By 53 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.89	14.44
2	30.87	14.15
3	32.85	13.90
4	34.84	13.69
5	36.83	13.52
6	38.83	13.39
7	40.83	13.30
8	42.83	13.25
9	44.83	13.24
10	46.83	13.27
11	48.83	13.34
12	50.82	13.45
13	52.82	13.61
14	54.81	13.80
15	56.79	14.03
16	58.78	14.30
17	60.75	14.61
18	62.72	14.97
19	64.68	15.36
20	66.63	15.79
21	68.58	16.26
22	70.51	16.77
23	72.43	17.32
24	74.35	17.90
25	76.25	18.53
26	78.13	19.19
27	80.01	19.89
28	81.86	20.63
29	83.71	21.41
30	85.53	22.22
31	87.34	23.07
32	89.14	23.96
33	90.91	24.88
34	92.67	25.84
35	94.40	26.84
36	96.12	27.87
37	97.81	28.93
38	99.48	30.03
39	101.13	31.16
40	102.76	32.32
41	104.36	33.52
42	105.94	34.74
43	107.50	36.00
44	109.02	37.29
45	110.52	38.62
46	112.00	39.97
47	113.45	41.35
48	114.86	42.76
49	116.25	44.20
50	117.61	45.66

51	118.94	47.16
52	120.24	48.67
53	121.33	50.00

Circle Center At X = 44.3 ; Y = 112.3 and Radius, 99.1

*** 1.370 ***

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.65	23.05
3	50.63	22.81
4	52.62	22.62
5	54.62	22.49
6	56.62	22.41
7	58.62	22.38
8	60.62	22.40
9	62.62	22.48
10	64.61	22.60
11	66.60	22.78
12	68.59	23.01
13	70.57	23.29
14	72.54	23.63
15	74.51	24.01
16	76.46	24.45
17	78.40	24.93
18	80.32	25.47
19	82.24	26.06
20	84.13	26.69
21	86.01	27.38
22	87.87	28.11
23	89.71	28.89
24	91.53	29.72
25	93.33	30.60
26	95.10	31.52
27	96.85	32.49
28	98.58	33.51
29	100.27	34.57
30	101.94	35.67
31	103.58	36.81
32	105.19	38.00
33	106.77	39.23
34	108.31	40.50
35	109.83	41.81
36	111.30	43.16
37	112.74	44.55
38	114.15	45.97
39	115.52	47.43
40	116.84	48.92
41	117.75	50.00

Circle Center At X = 58.7 ; Y = 99.2 and Radius, 76.9

*** 1.372 ***

1

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.22	21.11
2	44.14	20.55
3	46.08	20.07
4	48.04	19.67
5	50.02	19.35
6	52.00	19.10
7	54.00	18.94
8	55.99	18.85
9	57.99	18.84
10	59.99	18.92
11	61.99	19.07
12	63.97	19.30
13	65.95	19.61
14	67.91	20.00
15	69.85	20.47
16	71.78	21.02
17	73.68	21.64
18	75.55	22.33
19	77.40	23.10
20	79.21	23.95
21	80.99	24.86
22	82.73	25.85
23	84.43	26.90
24	86.09	28.02
25	87.70	29.21
26	89.26	30.46
27	90.77	31.77
28	92.23	33.14
29	93.63	34.57
30	94.97	36.05
31	96.26	37.58
32	97.48	39.17
33	98.63	40.80
34	99.72	42.47
35	100.75	44.19
36	101.70	45.95
37	102.58	47.75
38	103.40	49.57
39	103.56	50.00

Circle Center At X = 57.2 ; Y = 69.0 and Radius, 50.1

*** 1.387 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.22	21.11
2	44.13	20.51
3	46.06	20.00
4	48.02	19.57
5	49.99	19.23
6	51.97	18.98
7	53.96	18.81
8	55.96	18.74
9	57.96	18.76
10	59.96	18.86
11	61.95	19.06
12	63.93	19.35
13	65.90	19.72
14	67.84	20.18
15	69.77	20.73
16	71.66	21.36
17	73.53	22.08
18	75.36	22.88
19	77.16	23.76
20	78.91	24.72
21	80.62	25.76
22	82.28	26.87
23	83.89	28.06
24	85.44	29.32
25	86.94	30.65
26	88.38	32.04
27	89.75	33.50
28	91.05	35.01
29	92.29	36.58
30	93.45	38.21
31	94.54	39.89
32	95.56	41.61
33	96.49	43.38
34	97.35	45.19
35	98.12	47.03
36	98.81	48.91
37	99.00	49.50

Circle Center At X = 56.6 ; Y = 63.4 and Radius, 44.6

*** 1.411 ***

1

Failure Surface Specified By 65 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	10.00
2	21.98	9.75
3	23.97	9.52
4	25.96	9.32
5	27.95	9.16
6	29.95	9.02
7	31.95	8.91

8	33.95	8.83
9	35.94	8.78
10	37.94	8.76
11	39.94	8.76
12	41.94	8.80
13	43.94	8.87
14	45.94	8.96
15	47.94	9.09
16	49.93	9.24
17	51.92	9.42
18	53.91	9.63
19	55.90	9.87
20	57.88	10.14
21	59.86	10.44
22	61.83	10.77
23	63.80	11.12
24	65.76	11.51
25	67.72	11.92
26	69.67	12.36
27	71.61	12.83
28	73.55	13.33
29	75.48	13.85
30	77.40	14.41
31	79.31	14.99
32	81.22	15.60
33	83.11	16.24
34	85.00	16.90
35	86.88	17.60
36	88.74	18.32
37	90.60	19.07
38	92.44	19.84
39	94.27	20.64
40	96.09	21.47
41	97.90	22.32
42	99.70	23.20
43	101.48	24.11
44	103.25	25.04
45	105.01	26.00
46	106.75	26.98
47	108.47	27.99
48	110.19	29.03
49	111.88	30.09
50	113.56	31.17
51	115.23	32.28
52	116.88	33.41
53	118.51	34.57
54	120.12	35.75
55	121.72	36.95
56	123.30	38.18
57	124.86	39.43
58	126.41	40.70
59	127.93	41.99
60	129.44	43.31
61	130.92	44.65
62	132.39	46.01
63	133.84	47.39
64	135.26	48.79
65	136.46	50.00

Circle Center At X =   38.4 ; Y = 145.9 and Radius, 137.1

***   1.412   ***

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.63	22.95
3	50.60	22.62
4	52.59	22.36
5	54.58	22.16
6	56.57	22.02
7	58.57	21.95
8	60.57	21.94
9	62.57	22.00
10	64.57	22.11
11	66.56	22.29
12	68.54	22.54
13	70.52	22.84
14	72.48	23.21
15	74.44	23.64
16	76.38	24.14
17	78.30	24.69
18	80.20	25.31
19	82.08	25.98
20	83.94	26.71
21	85.78	27.51
22	87.59	28.36
23	89.37	29.26
24	91.13	30.23
25	92.85	31.25
26	94.53	32.32
27	96.19	33.44
28	97.80	34.62
29	99.38	35.85
30	100.92	37.13
31	102.42	38.45
32	103.87	39.83
33	105.29	41.24
34	106.65	42.70
35	107.97	44.21
36	109.24	45.75
37	110.46	47.34
38	111.63	48.96
39	112.33	50.00

Circle Center At X = 59.9 ; Y = 85.0 and Radius, 63.1

*** 1.414 ***

1

Failure Surface Specified By 38 Coordinate Points

Point X-Surf Y-Surf

No.	(ft)	(ft)
1	28.89	14.44
2	30.87	14.20
3	32.87	14.01
4	34.86	13.89
5	36.86	13.84
6	38.86	13.85
7	40.86	13.93
8	42.85	14.08
9	44.84	14.29
10	46.82	14.56
11	48.80	14.90
12	50.75	15.31
13	52.70	15.78
14	54.63	16.31
15	56.53	16.91
16	58.42	17.57
17	60.29	18.29
18	62.13	19.07
19	63.94	19.91
20	65.73	20.81
21	67.49	21.77
22	69.21	22.78
23	70.90	23.85
24	72.55	24.98
25	74.16	26.16
26	75.74	27.39
27	77.27	28.68
28	78.76	30.01
29	80.21	31.39
30	81.61	32.82
31	82.96	34.30
32	84.26	35.81
33	85.51	37.37
34	86.72	38.97
35	87.86	40.61
36	88.95	42.29
37	89.99	44.00
38	90.77	45.39

Circle Center At X = 37.5 ; Y = 74.7 and Radius, 60.8

*** 1.430 ***

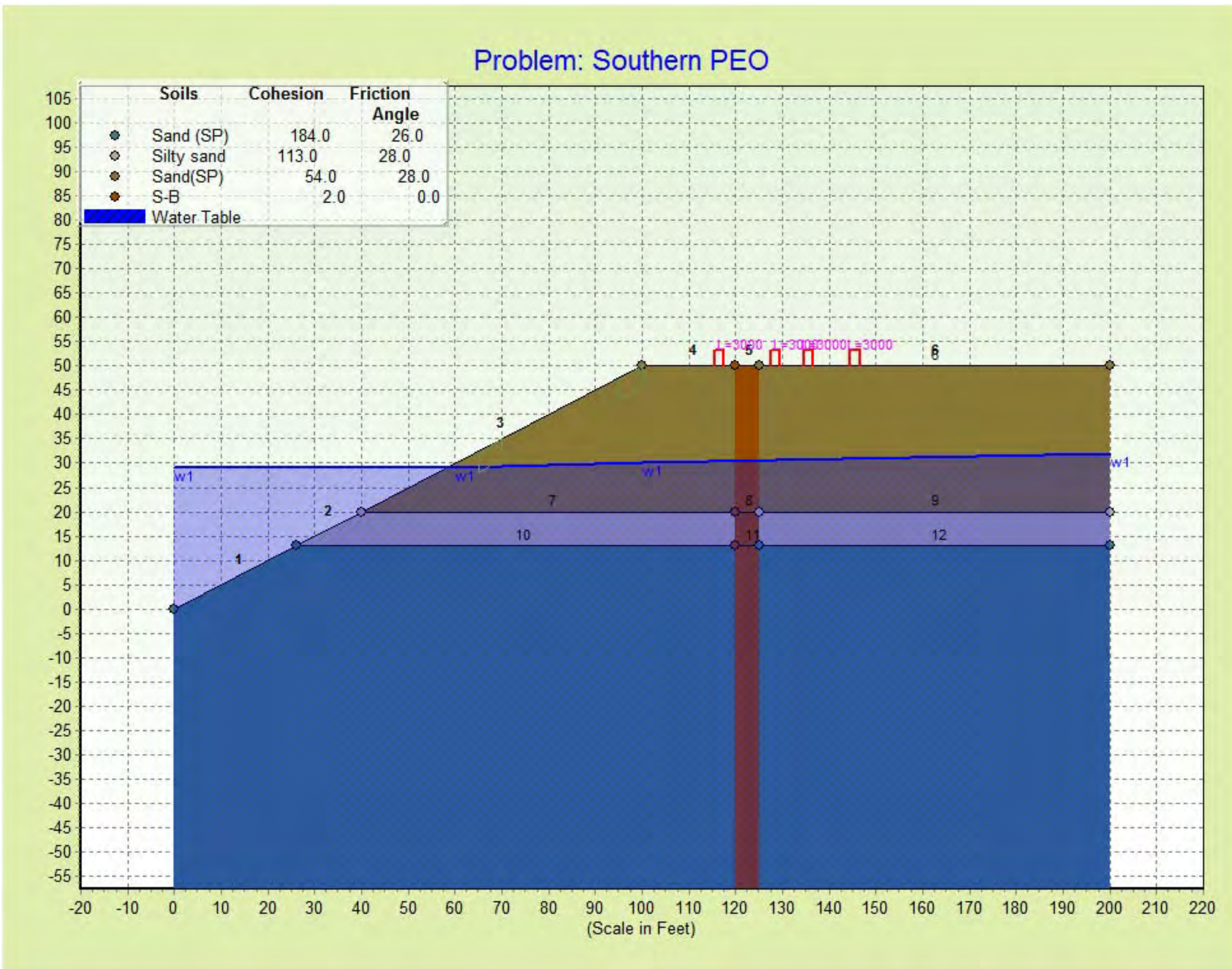
Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.44	12.22
2	26.41	11.87
3	28.39	11.58
4	30.38	11.35
5	32.37	11.17
6	34.37	11.04
7	36.37	10.98
8	38.37	10.97

```
    9          40.37       11.02
   10          42.36       11.12
   11          44.36       11.28
   12          46.34       11.50
   13          48.33       11.77
   14          50.30       12.10
   15          52.26       12.49
   16          54.21       12.93
   17          56.15       13.42
   18          58.07       13.98
   19          59.98       14.58
   20          61.87       15.24
   21          63.73       15.95
   22          65.58       16.72
   23          67.41       17.54
   24          69.21       18.41
   25          70.98       19.33
   26          72.73       20.30
   27          74.45       21.31
   28          76.15       22.38
   29          77.81       23.50
   30          79.43       24.66
   31          81.03       25.87
   32          82.59       27.12
   33          84.11       28.42
   34          85.60       29.75
   35          87.04       31.13
   36          88.45       32.56
   37          89.82       34.02
   38          91.14       35.51
   39          92.42       37.05
   40          93.66       38.62
   41          94.85       40.23
   42          96.00       41.87
   43          97.10       43.54
   44          98.15       45.24
   45          99.15       46.97
   46         100.11       48.73
   47         100.75       50.00

Circle Center At X =   37.7 ; Y =   81.4  and Radius,   70.5

      ***     1.431   ***


1

           Y            A     X     I     S           F     T


           0.00     25.00     50.00     75.00    100.00    125.00

X      0.00 *---------+-W-------+---------+---------+---------+
            -
            -
            -
            -
            -   7
      25.00 + ..7*
            - ..701
            -...721.
```

```
                   -...721..
                   -...721.*
                   -...721.54
A      50.00 +...729154.
                   ....732154..
                   ....7.2114..W
                   ....7.2214....
                   .....73251.....
                   .....7.2211....
X      75.00 .....7732511....
                   ......7.324199...
                   ......773324199...
                   .......7.332211999.
                   ........7.3.2211..9.
                   -.......77.33422166.
I     100.00 +........77.W4482116*
                   -.........7..3348.111
                   - .........77.33448 2
                   -  .........7..333488
                   -   .........77..33441/1
                   -    *..*.....77...3*
S     125.00 +    *..*......77...*
                   -       .........77..2/2
                   -        .........777/3
                   -           ........73/
                   -              ......
                   -                 ...4/4
      150.00 +
                   -
                   -
                   -
                   -
                   -
F     175.00 +
                   -
                   -
                   -
                   -
                   -
T     200.00 +    *  *    W      *
```

================== DATA SUMMARY =====================



Profile Data

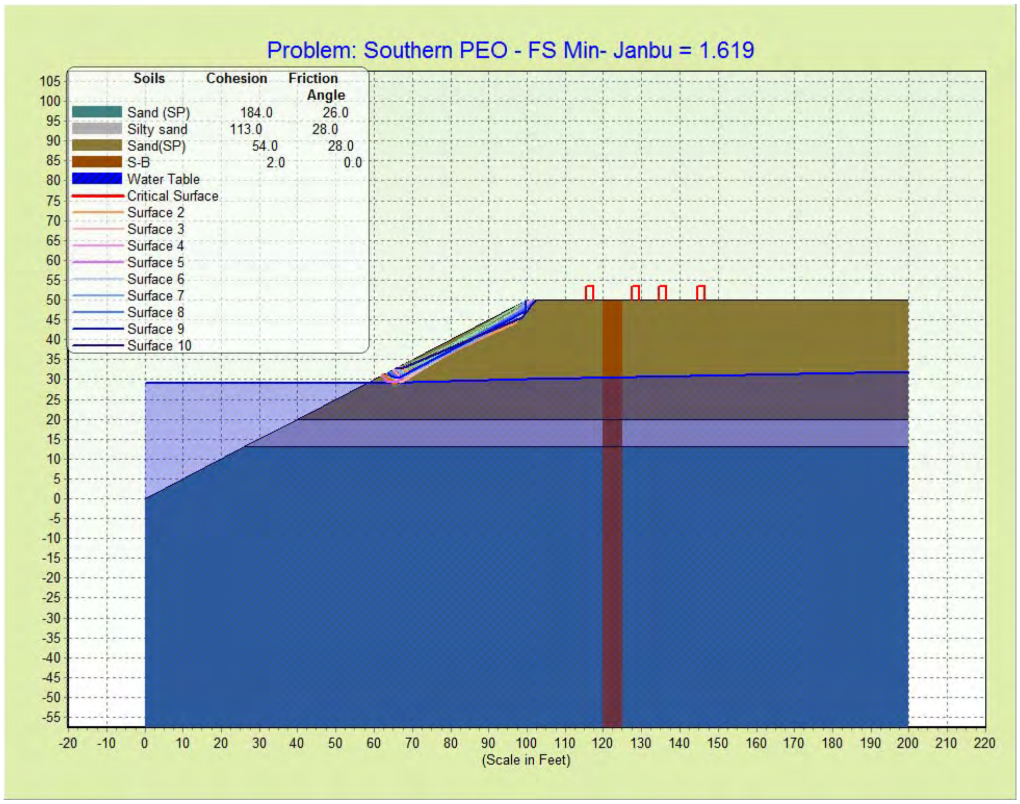
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

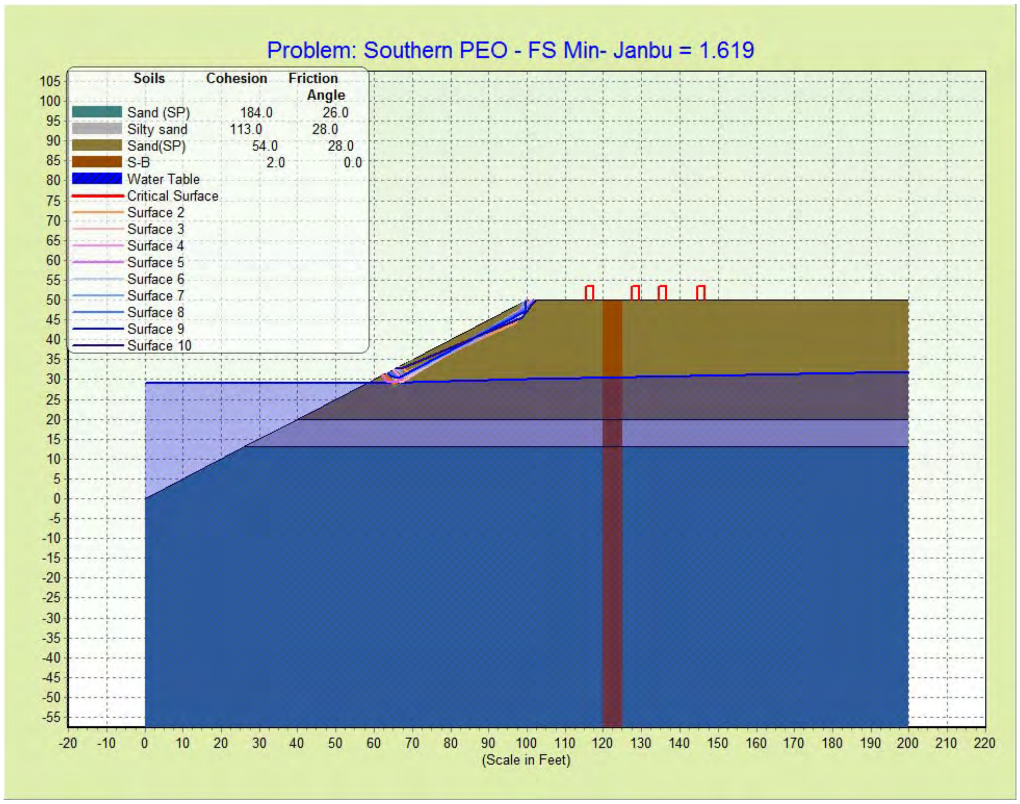
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	100.00	30.00
4	200.00	32.00

1

BOUNDARY LOAD(S)

4 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	115.50	117.50	3000.0	0.0
2	127.50	129.50	3000.0	0.0
3	134.50	136.50	3000.0	0.0
4	144.50	146.50	3000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

20 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is   2.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)

1	65.00	30.00	70.00	33.00	4.00
2	95.00	45.00	100.00	48.00	4.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	62.27	31.14
2	63.54	30.01
3	65.26	28.99
4	98.43	46.02
5	99.56	47.67
6	100.97	49.09
7	101.64	50.00

*** 1.619 ***

Individual data on the 9 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.3	124.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5	427.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.2	90.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0
4	0.3	117.3	0.0	1.4	0.0	0.0	0.0	0.0	0.0
5	32.9	12461.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.1	332.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.4	97.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.7	33.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.44	33.22
2	67.07	32.95
3	68.75	31.87
4	97.06	44.28
5	98.02	46.04
6	99.09	47.73
7	100.35	49.28

8	100.92	50.00

*** 1.624 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.34	31.67
2	63.82	31.42
3	65.33	30.10
4	67.18	29.35
5	99.79	48.34
6	101.20	49.75
7	101.33	50.00

*** 1.702 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	64.77	32.39
2	65.71	31.80
3	67.18	30.44
4	98.78	46.32
5	99.48	48.19
6	100.88	49.61
7	100.92	50.00

*** 1.704 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	61.95	30.97
2	62.12	30.82
3	63.54	29.41
4	65.54	29.36
5	97.59	46.85
6	98.65	48.54
7	99.00	49.50

*** 1.708 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.54	32.77
2	66.45	32.08
3	67.87	30.67
4	99.37	46.73
5	100.78	48.15
6	101.57	49.99
7	101.59	50.00

*** 1.710 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.63	32.82
2	66.53	32.38
3	67.95	30.96
4	96.20	44.70
5	97.61	46.12
6	98.74	47.77
7	98.88	49.44

*** 1.712 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.82	31.91
2	64.77	31.40
3	66.42	30.27
4	99.78	47.79
5	101.07	49.32
6	101.71	50.00

*** 1.729 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.44	31.72
2	64.43	30.94
3	66.34	30.35
4	99.34	47.08
5	99.69	49.05
6	99.74	49.87

***   1.734   ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.36	32.68
2	67.01	32.61
3	98.73	45.67
4	99.99	47.23
5	101.21	48.81
6	102.37	50.00

***   1.742   ***

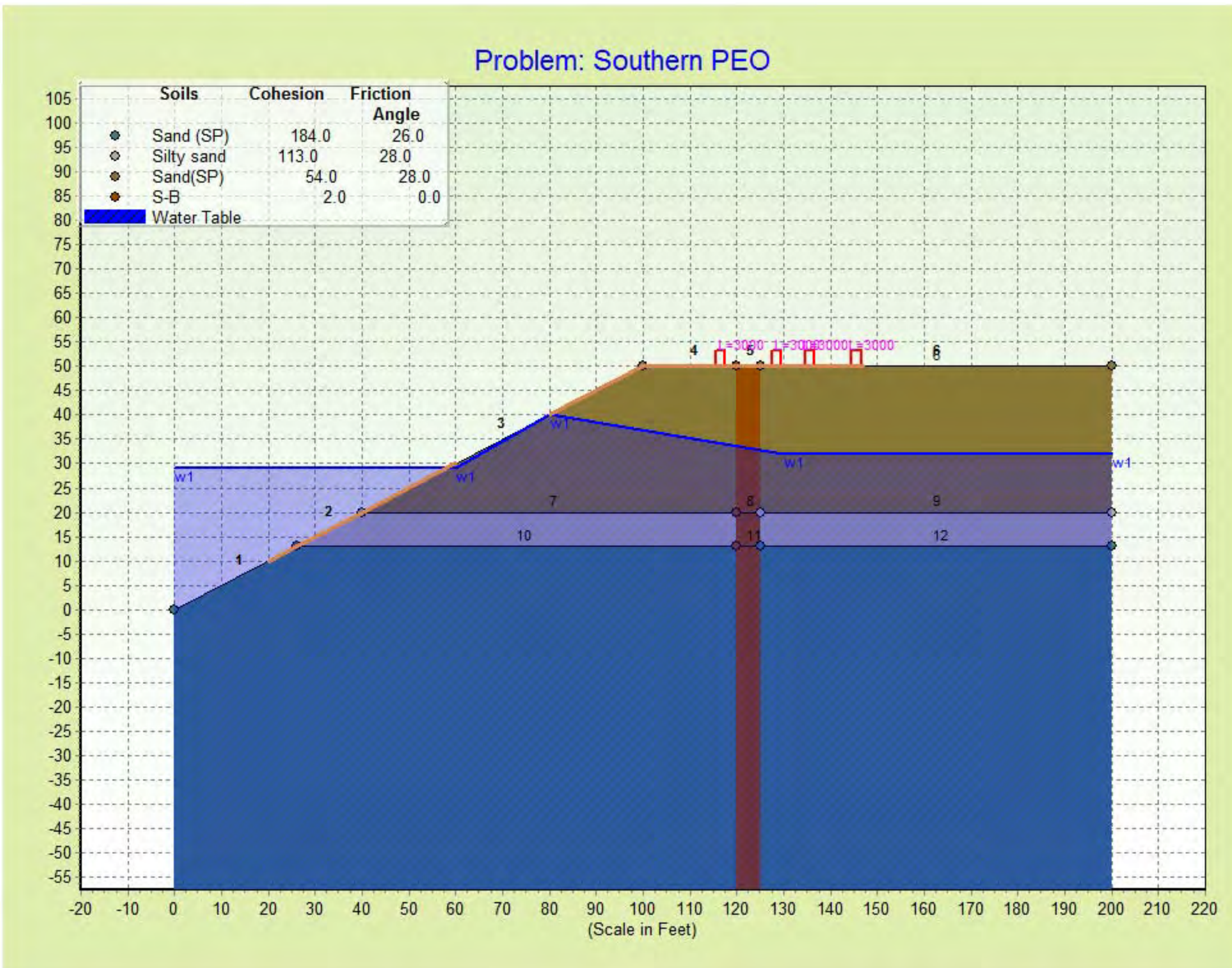
1

```
           Y            A     X     I     S            F     T

           0.00     25.00     50.00     75.00    100.00    125.00

X      0.00 *---------+-W-------+---------+---------+---------+
            -
            -
            -
            -
            -
      25.00 +    *
            -
            -
            -
            -       *
            -
A     50.00 +
            -
```

```
                -          W
                -          13
                -          12.
                -          .2
X      75.00 +
                -
                -
                -
                -
                -                25
I     100.00 +          W      11*
                -                  0
                -
                -
                -                   1/1
                -    *  *           *
S     125.00 +    *  *           *
                -                   2/2
                -                   /3
                -                   3/
                -
                -                   4/4
      150.00 +
                -
                -
                -
                -
                -
F     175.00 +
                -
                -
                -
                -
                -
T     200.00 +    *  *    W       *
```

Appendix C.4
During Construction, Rapid Drawdown Condition

================== DATA SUMMARY ====================



Profile Data

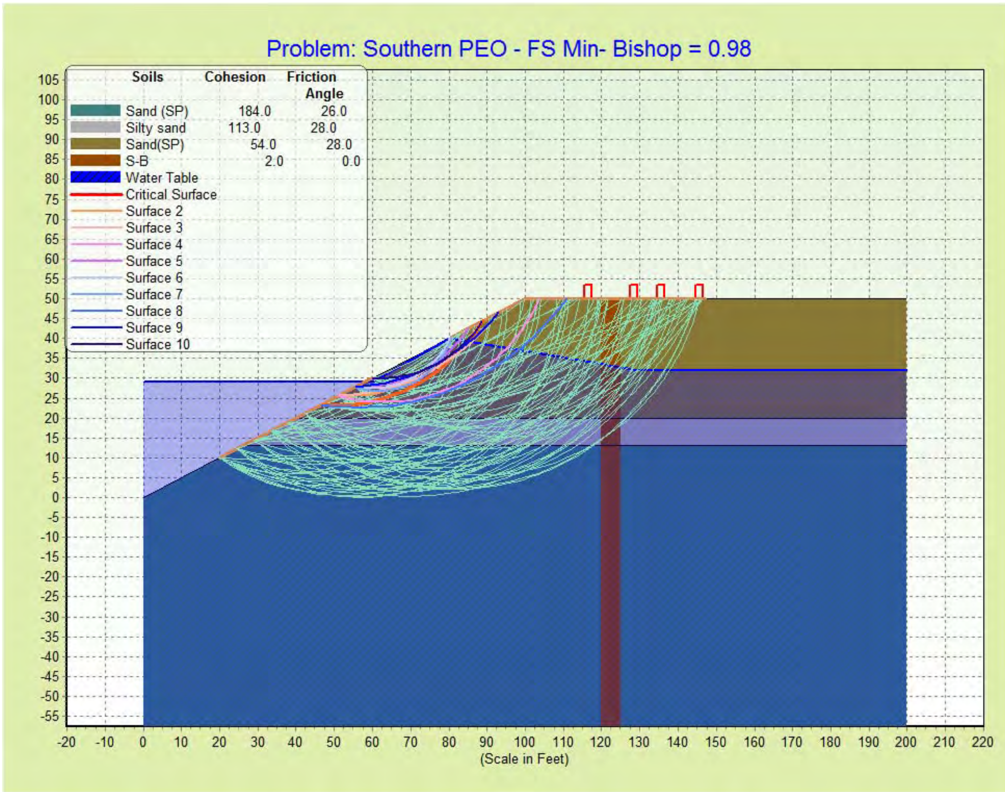
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

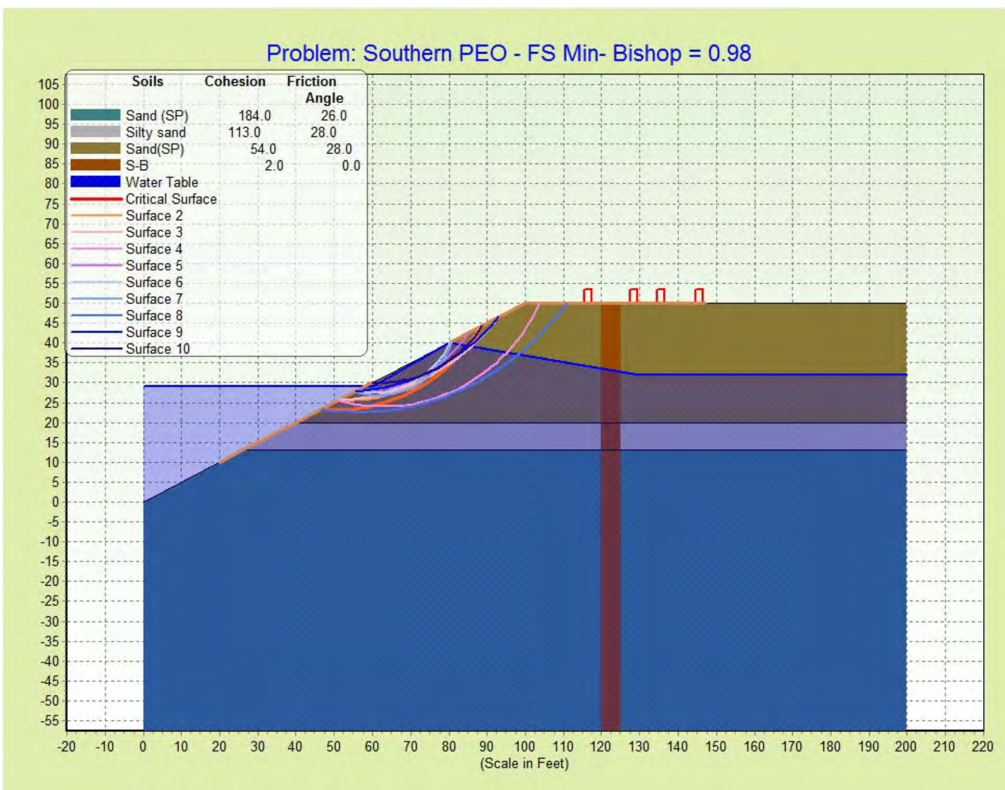
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	80.00	40.00
4	130.00	32.00
5	200.00	32.00

1

BOUNDARY LOAD(S)

4 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	115.50	117.50	3000.0	0.0
2	127.50	129.50	3000.0	0.0
3	134.50	136.50	3000.0	0.0
4	144.50	146.50	3000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 20.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 80.00 ft.
and X = 147.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation

At Which A Surface Extends Is Y = 0.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.66	23.21
3	50.66	23.18
4	52.66	23.24
5	54.66	23.38
6	56.64	23.61
7	58.62	23.93
8	60.58	24.34
9	62.52	24.83
10	64.43	25.41
11	66.32	26.07
12	68.18	26.81
13	70.00	27.63
14	71.78	28.54
15	73.53	29.52
16	75.22	30.57
17	76.87	31.71
18	78.47	32.91
19	80.02	34.18
20	81.50	35.52
21	82.93	36.92
22	84.29	38.38
23	85.59	39.90
24	86.82	41.48
25	87.98	43.11
26	88.82	44.41

Circle Center At X =   50.4 ; Y =   68.6 and Radius,   45.4

***   0.980   ***

Individual data on the   28 slices

Water Force	Water Force	Force	Force	Earthquake Force	Surcharge

Slice No.	Width (ft)	Weight (lbs)	Top (lbs)	Bot (lbs)	Norm (lbs)	Tan (lbs)	Hor (lbs)	Ver (lbs)	Load (lbs)
1	2.0	131.7	719.7	714.6	0.0	0.0	0.0	0.0	0.0
2	2.0	385.5	581.5	724.1	0.0	0.0	0.0	0.0	0.0
3	2.0	618.4	441.9	722.6	0.0	0.0	0.0	0.0	0.0
4	2.0	828.4	302.0	710.1	0.0	0.0	0.0	0.0	0.0
5	2.0	1014.2	162.8	686.6	0.0	0.0	0.0	0.0	0.0
6	2.0	1174.5	25.4	652.2	0.0	0.0	0.0	0.0	0.0
7	1.4	903.1	0.0	433.5	0.0	0.0	0.0	0.0	0.0
8	0.6	392.7	0.0	158.5	0.0	0.0	0.0	0.0	0.0
9	1.9	1394.7	0.0	580.8	0.0	0.0	0.0	0.0	0.0
10	1.9	1475.3	0.0	638.8	0.0	0.0	0.0	0.0	0.0
11	1.9	1528.9	0.0	685.9	0.0	0.0	0.0	0.0	0.0
12	1.9	1556.1	0.0	722.1	0.0	0.0	0.0	0.0	0.0
13	1.8	1557.4	0.0	747.4	0.0	0.0	0.0	0.0	0.0
14	1.8	1533.9	0.0	761.5	0.0	0.0	0.0	0.0	0.0
15	1.7	1486.9	0.0	764.6	0.0	0.0	0.0	0.0	0.0
16	1.7	1418.0	0.0	756.7	0.0	0.0	0.0	0.0	0.0
17	1.6	1329.1	0.0	737.6	0.0	0.0	0.0	0.0	0.0
18	1.6	1222.2	0.0	707.5	0.0	0.0	0.0	0.0	0.0
19	1.5	1088.8	0.0	659.8	0.0	0.0	0.0	0.0	0.0
20	0.0	11.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0
21	1.5	964.7	0.0	620.1	0.0	0.0	0.0	0.0	0.0
22	1.4	808.2	0.0	422.6	0.0	0.0	0.0	0.0	0.0
23	1.4	645.6	0.0	218.5	0.0	0.0	0.0	0.0	0.0
24	0.7	276.2	0.0	30.9	0.0	0.0	0.0	0.0	0.0
25	0.6	205.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	1.2	328.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	1.2	180.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.8	40.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.50
3	55.11	25.55
4	57.11	25.68
5	59.09	25.91
6	61.07	26.24
7	63.02	26.65
8	64.96	27.16
9	66.87	27.76
10	68.74	28.45
11	70.59	29.22
12	72.39	30.08
13	74.15	31.03
14	75.87	32.06
15	77.54	33.16
16	79.15	34.35
17	80.70	35.61
18	82.19	36.94
19	83.62	38.34
20	84.98	39.80
21	86.28	41.33
22	87.49	42.92
23	88.38	44.19

Circle Center At X = 53.2 ; Y = 68.0 and Radius, 42.4

***   0.987   ***

1

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.65
3	55.10	25.81
4	57.09	26.05
5	59.06	26.36
6	61.03	26.74
7	62.98	27.19
8	64.91	27.71
9	66.82	28.29
10	68.71	28.95
11	70.57	29.68
12	72.41	30.47
13	74.22	31.32
14	75.99	32.24
15	77.73	33.23
16	79.44	34.27
17	81.11	35.38
18	82.73	36.55
19	84.31	37.77
20	85.85	39.05
21	87.34	40.38
22	88.78	41.77
23	90.17	43.21
24	91.51	44.69
25	92.79	46.23
26	93.01	46.50

Circle Center At X =   49.5 ; Y =   81.1 and Radius,   55.6

***   1.010   ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.05	25.08
3	55.01	24.68
4	56.99	24.38
5	58.98	24.16
6	60.98	24.03
7	62.97	23.99
8	64.97	24.04
9	66.97	24.18

10	68.96	24.40
11	70.93	24.72
12	72.89	25.12
13	74.83	25.61
14	76.75	26.18
15	78.64	26.83
16	80.50	27.57
17	82.32	28.40
18	84.10	29.30
19	85.85	30.28
20	87.55	31.33
21	89.20	32.46
22	90.79	33.66
23	92.34	34.94
24	93.82	36.27
25	95.25	37.68
26	96.61	39.14
27	97.91	40.67
28	99.13	42.25
29	100.29	43.88
30	101.37	45.56
31	102.37	47.29
32	103.30	49.06
33	103.74	50.00

Circle Center At X = 62.9 ; Y = 69.1 and Radius, 45.1

*** 1.040 ***

1

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.56	27.76
3	59.55	27.86
4	61.54	28.08
5	63.51	28.41
6	65.46	28.86
7	67.38	29.42
8	69.27	30.09
9	71.11	30.87
10	72.90	31.76
11	74.64	32.75
12	76.32	33.83
13	77.93	35.02
14	79.47	36.29
15	80.94	37.66
16	82.32	39.10
17	83.61	40.63
18	84.82	42.22
19	85.00	42.50

Circle Center At X = 56.8 ; Y = 62.1 and Radius, 34.3

*** 1.044 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.54	27.52
3	59.54	27.42
4	61.54	27.50
5	63.52	27.76
6	65.47	28.18
7	67.39	28.76
8	69.24	29.51
9	71.03	30.41
10	72.73	31.47
11	74.33	32.66
12	75.83	33.99
13	77.20	35.44
14	78.45	37.00
15	79.56	38.67
16	80.40	40.20

Circle Center At X = 59.6 ; Y = 50.7 and Radius, 23.3

*** 1.070 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.49	27.27
3	59.46	26.95
4	61.46	26.83
5	63.46	26.91
6	65.44	27.18
7	67.38	27.65
8	69.27	28.31
9	71.09	29.15
10	72.81	30.17
11	74.42	31.35
12	75.91	32.69
13	77.26	34.17
14	78.45	35.77
15	79.48	37.49
16	80.34	39.29
17	80.72	40.36

Circle Center At X = 61.7 ; Y = 47.0 and Radius, 20.2

*** 1.070 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.65	23.07
3	50.64	22.87
4	52.63	22.73
5	54.63	22.64
6	56.63	22.62
7	58.63	22.65
8	60.63	22.75
9	62.62	22.90
10	64.61	23.11
11	66.59	23.38
12	68.57	23.71
13	70.53	24.10
14	72.48	24.55
15	74.42	25.05
16	76.34	25.61
17	78.24	26.23
18	80.12	26.90
19	81.98	27.63
20	83.82	28.41
21	85.64	29.25
22	87.43	30.14
23	89.19	31.08
24	90.93	32.08
25	92.63	33.12
26	94.31	34.22
27	95.95	35.36
28	97.55	36.56
29	99.12	37.80
30	100.65	39.08
31	102.15	40.41
32	103.60	41.79
33	105.01	43.20
34	106.38	44.66
35	107.70	46.16
36	108.99	47.70
37	110.22	49.27
38	110.76	50.00

Circle Center At X = 56.5 ; Y = 90.1 and Radius, 67.5

*** 1.076 ***

1

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.55	27.94
3	59.54	28.18
4	61.51	28.49
5	63.47	28.87
6	65.42	29.33
7	67.35	29.86
8	69.26	30.46
9	71.14	31.13
10	73.00	31.87
11	74.83	32.68
12	76.62	33.56
13	78.39	34.51
14	80.11	35.51
15	81.80	36.59
16	83.45	37.72
17	85.05	38.92
18	86.61	40.17
19	88.12	41.49
20	89.58	42.85
21	90.98	44.28
22	92.34	45.75
23	92.96	46.48

Circle Center At X =   52.2 ; Y =   81.3 and Radius,   53.6

*** 1.077 ***

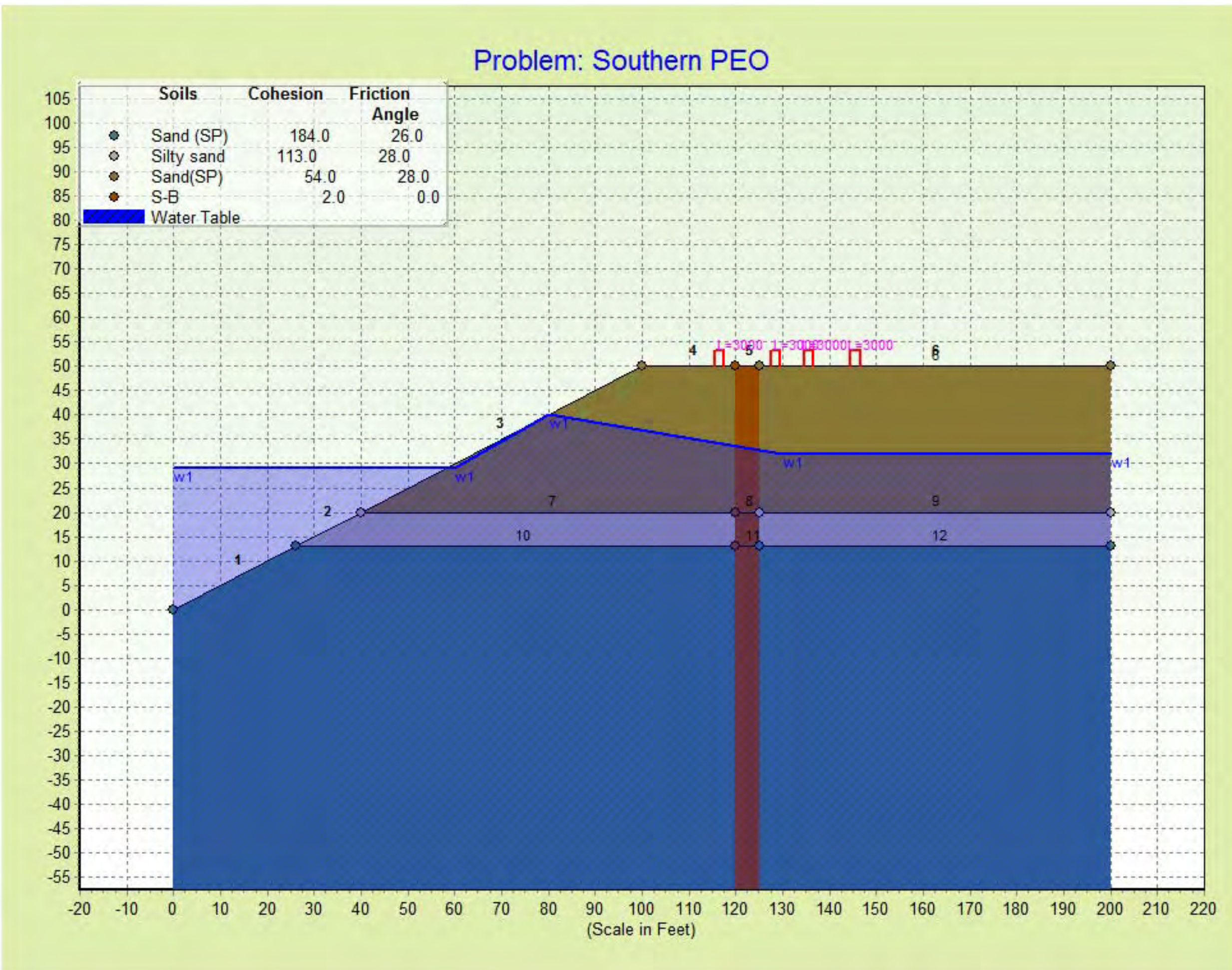
Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.00	30.00
2	62.00	29.94
3	64.00	30.00
4	65.99	30.19
5	67.97	30.50
6	69.92	30.93
7	71.84	31.49
8	73.72	32.17
9	75.56	32.96
10	77.34	33.87
11	79.06	34.88
12	80.72	36.00
13	82.30	37.23
14	83.80	38.55
15	85.22	39.96
16	86.54	41.46
17	87.77	43.04
18	88.65	44.33

Circle Center At X =   62.0 ; Y =   61.8 and Radius,   31.9

```
                ***     1.092   ***


1

                     Y            A     X     I     S            F     T

                     0.00     25.00     50.00     75.00    100.00    125.00
          X      0.00 *---------+-W-------+---------+---------+---------+
                      -
                      -
                      -
                      -
                      -   .
                25.00 + ...*
                      - .....
                      -.......
                      -........
                      -.......*
                      .........1
          A     50.00 .........12
                      .........125
                      .........113W
                      .........8129.
                      .........8113.
                      ..........4125.
          X     75.00 ..........4.115.
                      ..........84.115W
                      -..........44.1125
                      -...........44..111
                      -............44..333
                      -.............844...
          I    100.00 + .............8844.*
                      - ..............88.44
                      -  ...............888
                      -   ................8
                      -    ................1/1
                      -    *..*...........*
          S    125.00 +    * .*...........*
                      -       .....W.......2/2
                      -         .........../3
                      -           .........3/
                      -              ......
                      -                 ...4/4
               150.00 +
                      -
                      -
                      -
                      -
                      -
          F    175.00 +
                      -
                      -
                      -
                      -
                      -
          T    200.00 +    *  *    W      *
```

================== DATA SUMMARY =====================



Profile Data

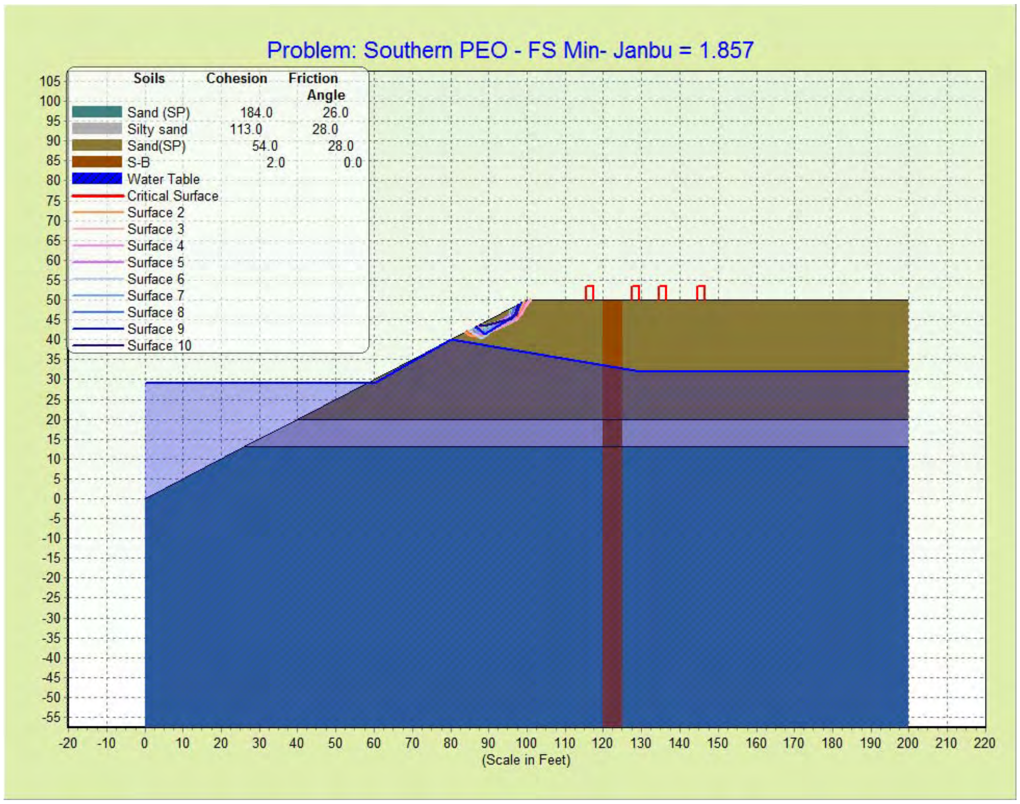
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

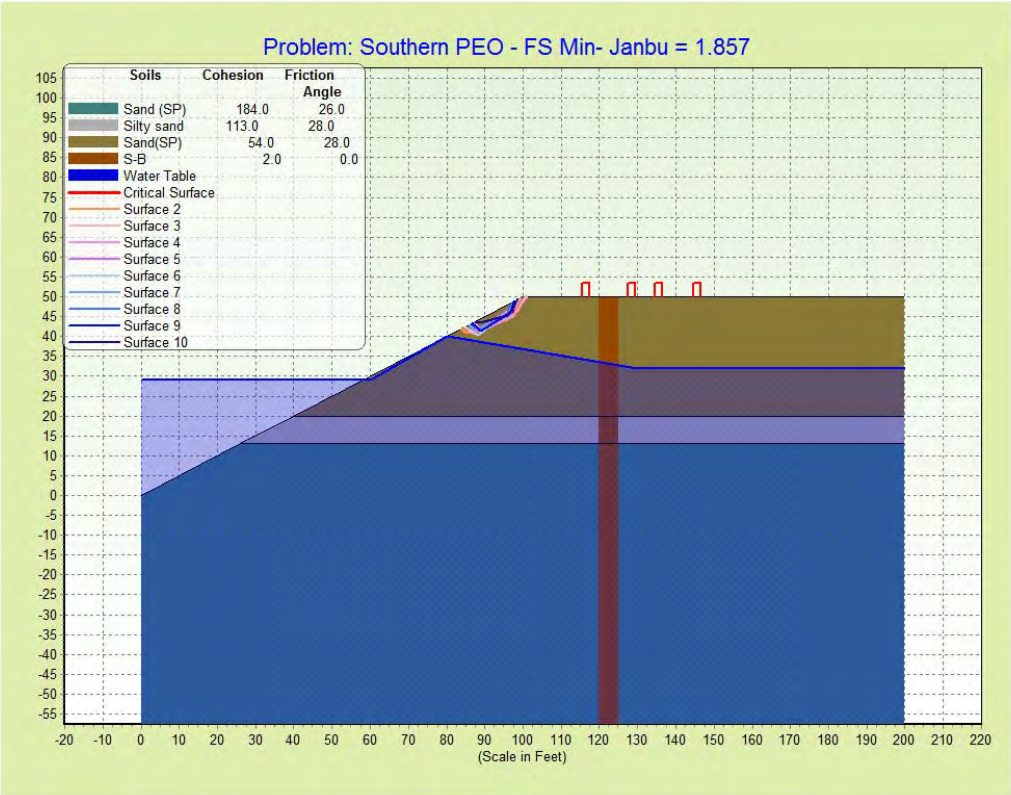
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION   Southern PEO

BOUNDARY COORDINATES

6 Top   Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	80.00	40.00
4	130.00	32.00
5	200.00	32.00

1

BOUNDARY LOAD(S)

4 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Deflection (deg)
1	115.50	117.50	3000.0	0.0
2	127.50	129.50	3000.0	0.0
3	134.50	136.50	3000.0	0.0
4	144.50	146.50	3000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

20 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 2.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)

1	87.00	41.00	90.00	43.00	3.00
2	95.00	45.00	98.00	47.00	3.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.17	42.09
2	85.18	41.19
3	87.15	40.83
4	96.72	45.36
5	98.13	46.78
6	99.34	48.37
7	100.75	49.79
8	100.84	50.00

*** 1.857 ***

Individual data on the 8 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	78.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0	452.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	9.6	3054.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.4	414.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.2	241.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.7	83.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.7	49.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	83.62	41.81
2	85.10	41.02
3	87.10	40.89
4	96.31	44.40
5	97.06	46.26
6	98.37	47.76

7	99.32	49.53
8	99.58	49.79

*** 1.934 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.78	42.89
2	86.00	42.79
3	87.47	41.42
4	97.24	45.15
5	98.59	46.63
6	99.61	48.35
7	100.94	49.85
8	101.05	50.00

*** 1.974 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.21	43.60
2	88.10	42.79
3	89.77	41.68
4	97.74	45.47
5	98.72	47.22
6	99.86	48.86
7	100.53	50.00

*** 2.069 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.89	42.45
2	86.12	41.58
3	88.11	41.47
4	96.66	47.23
5	97.80	48.88

6	97.84	48.92

*** 2.136 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.78	42.39
2	84.79	42.39
3	86.48	41.32
4	88.24	40.36
5	96.56	46.64
6	97.80	48.21
7	98.34	49.17

*** 2.149 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.78	42.89
2	87.08	41.64
3	96.44	45.28
4	97.04	47.19
5	98.44	48.62
6	98.73	49.37

*** 2.264 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.53	43.27
2	87.53	42.40
3	89.38	41.64
4	95.92	45.81
5	96.59	47.70
6	97.77	48.88

*** 2.299 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.49	43.24
2	87.36	42.64
3	88.82	41.27
4	97.21	46.41
5	97.89	48.29
6	98.70	49.35

*** 2.334 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.42	43.71
2	88.69	43.46
3	95.80	45.19
4	97.06	46.75
5	97.65	48.66
6	97.87	48.93

*** 2.340 ***

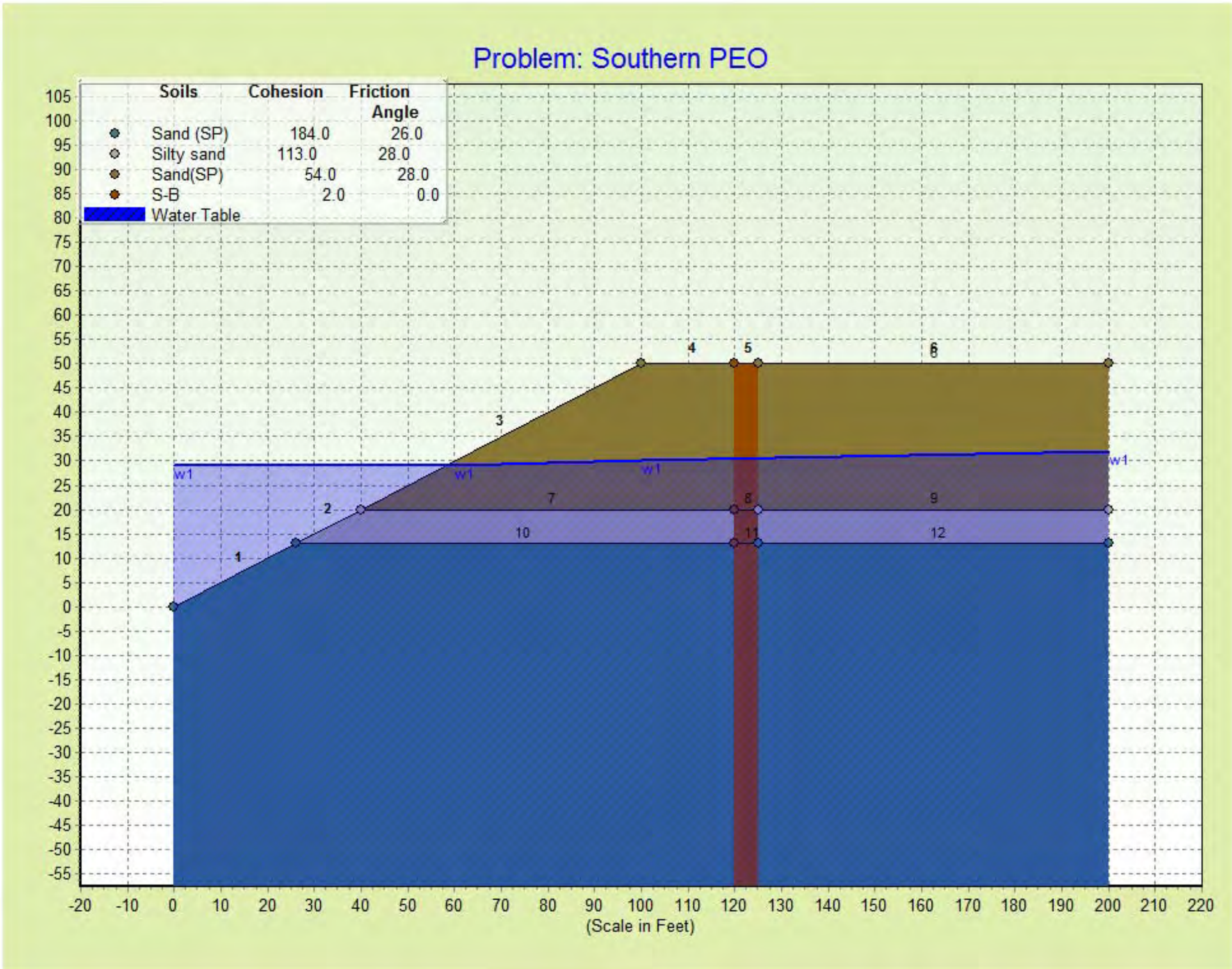
1

```
                     Y            A     X     I     S            F     T


                     0.00     25.00     50.00     75.00    100.00    125.00

          X      0.00 *---------+-W-------+---------+---------+---------+
                      -
                      -
                      -
                      -
                      -
                25.00 +    *
                      -
                      -
                      -
                      -       *
                      -
          A     50.00 +
                      -
```

```
                 -           W
                 -
                 -
                 -
X      75.00 +
                 -               W
                 -               11
                 -               13.
                 -                4
                 -                 125
I     100.00 +                      1*
                 -
                 -
                 -
                 -                     1/1
                 -    *  *             *
S     125.00 +    *  *             *
                 -            W        2/2
                 -                     /3
                 -                     3/
                 -
                 -                     4/4
      150.00 +
                 -
                 -
                 -
                 -
                 -
F     175.00 +
                 -
                 -
                 -
                 -
                 -
T     200.00 +    *  *    W        *
```

Appendix C.5
Post-Construction, Normal Groundwater Condition

================== DATA SUMMARY =====================



Profile Data

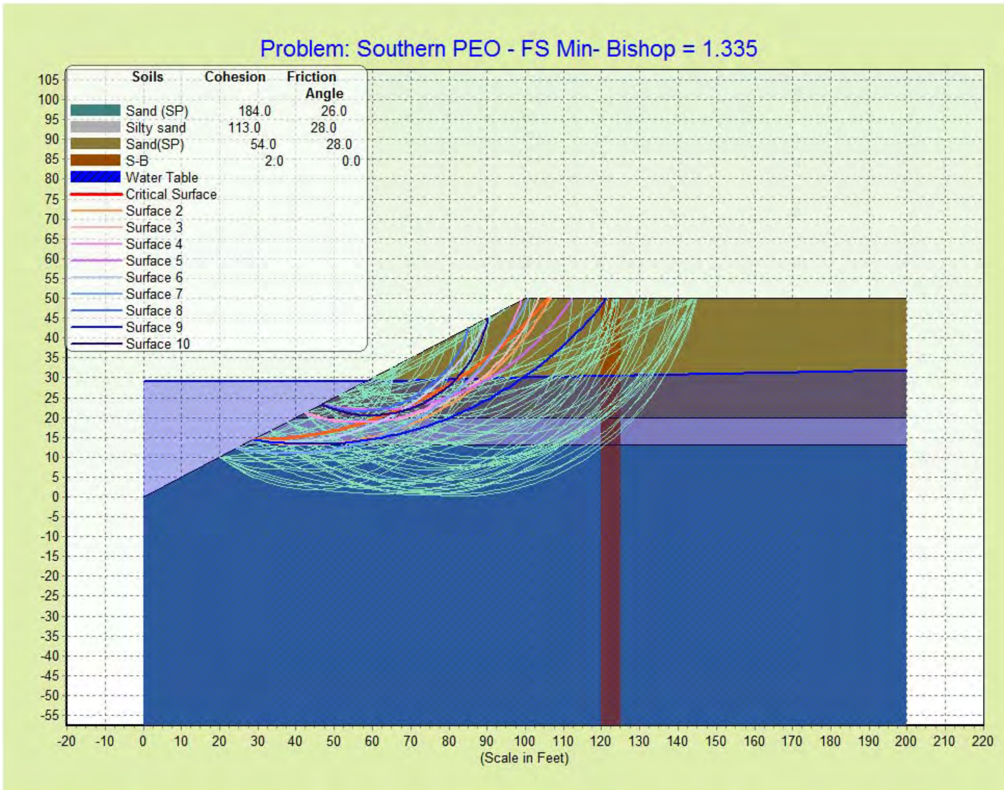
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

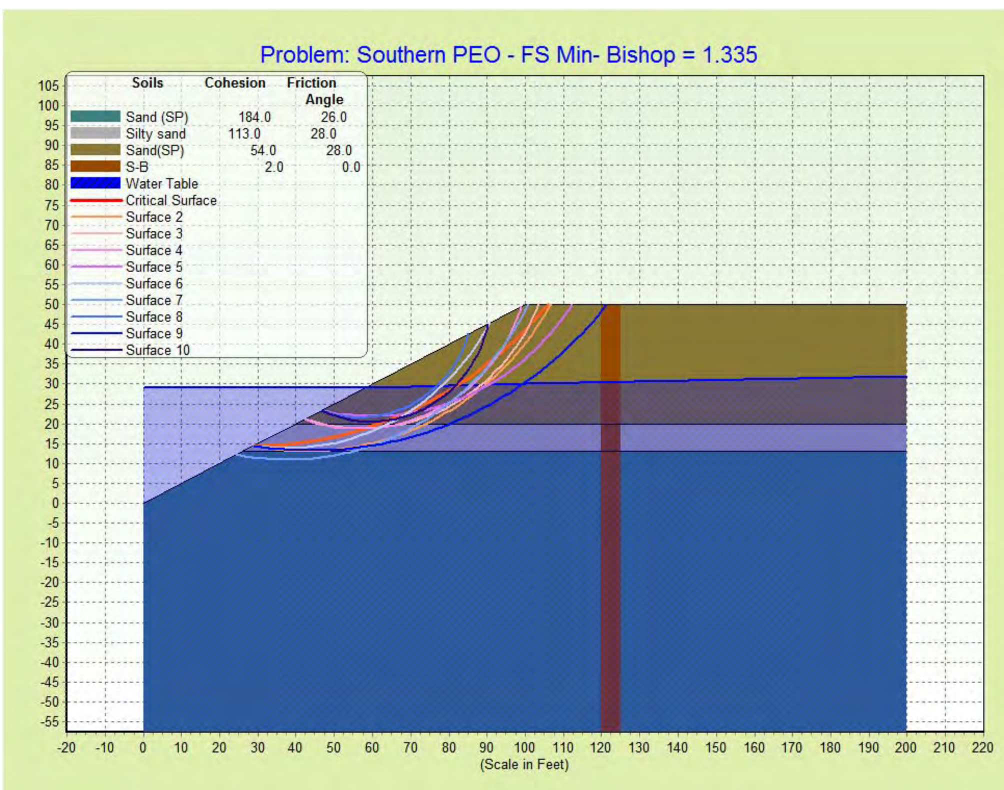
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	100.00	30.00
4	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 20.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 65.00 ft.
and X = 145.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 45 Coordinate Points

Point X-Surf Y-Surf

No.	(ft)	(ft)
1	28.89	14.44
2	30.89	14.47
3	32.89	14.53
4	34.89	14.64
5	36.88	14.78
6	38.87	14.96
7	40.86	15.18
8	42.84	15.44
9	44.82	15.74
10	46.79	16.08
11	48.76	16.45
12	50.71	16.87
13	52.66	17.32
14	54.60	17.81
15	56.53	18.34
16	58.45	18.91
17	60.35	19.51
18	62.25	20.15
19	64.13	20.83
20	66.00	21.54
21	67.85	22.29
22	69.69	23.08
23	71.51	23.90
24	73.32	24.76
25	75.11	25.65
26	76.88	26.58
27	78.63	27.55
28	80.37	28.54
29	82.08	29.57
30	83.77	30.64
31	85.45	31.74
32	87.10	32.87
33	88.72	34.03
34	90.33	35.22
35	91.91	36.45
36	93.47	37.70
37	95.00	38.99
38	96.51	40.30
39	97.99	41.65
40	99.44	43.02
41	100.87	44.42
42	102.27	45.85
43	103.64	47.31
44	104.98	48.79
45	106.03	50.00

Circle Center At X = 28.6 ; Y = 116.5 and Radius, 102.1

*** 1.335 ***

Individual data on the 49 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)

1	2.0	112.1	1961.0	1814.9	0.0	0.0	0.0	0.0	0.0
2	2.0	331.5	1820.7	1809.3	0.0	0.0	0.0	0.0	0.0
3	2.0	541.4	1680.0	1798.8	0.0	0.0	0.0	0.0	0.0
4	2.0	741.5	1539.1	1783.5	0.0	0.0	0.0	0.0	0.0
5	2.0	931.4	1398.1	1763.2	0.0	0.0	0.0	0.0	0.0
6	1.1	608.7	730.4	989.6	0.0	0.0	0.0	0.0	0.0
7	0.9	502.8	527.0	748.5	0.0	0.0	0.0	0.0	0.0
8	2.0	1285.5	1117.1	1708.1	0.0	0.0	0.0	0.0	0.0
9	2.0	1449.5	977.4	1673.3	0.0	0.0	0.0	0.0	0.0
10	2.0	1602.6	838.5	1633.6	0.0	0.0	0.0	0.0	0.0
11	2.0	1744.5	700.7	1589.1	0.0	0.0	0.0	0.0	0.0
12	2.0	1875.1	564.1	1539.9	0.0	0.0	0.0	0.0	0.0
13	1.9	1994.3	429.0	1485.8	0.0	0.0	0.0	0.0	0.0
14	1.9	2102.1	295.5	1427.0	0.0	0.0	0.0	0.0	0.0
15	1.9	2198.4	163.9	1363.4	0.0	0.0	0.0	0.0	0.0
16	1.9	2283.2	34.2	1295.1	0.0	0.0	0.0	0.0	0.0
17	1.6	1905.9	0.0	1000.8	0.0	0.0	0.0	0.0	0.0
18	0.4	441.2	0.0	221.3	0.0	0.0	0.0	0.0	0.0
19	1.5	1832.4	0.0	887.0	0.0	0.0	0.0	0.0	0.0
20	0.4	564.3	0.0	261.2	0.0	0.0	0.0	0.0	0.0
21	1.9	2432.9	0.0	1071.9	0.0	0.0	0.0	0.0	0.0
22	1.9	2456.9	0.0	990.9	0.0	0.0	0.0	0.0	0.0
23	1.9	2469.8	0.0	905.3	0.0	0.0	0.0	0.0	0.0
24	1.8	2471.9	0.0	815.1	0.0	0.0	0.0	0.0	0.0
25	1.8	2463.4	0.0	720.4	0.0	0.0	0.0	0.0	0.0
26	1.8	2444.4	0.0	621.2	0.0	0.0	0.0	0.0	0.0
27	1.8	2415.4	0.0	517.5	0.0	0.0	0.0	0.0	0.0
28	1.8	2376.4	0.0	409.4	0.0	0.0	0.0	0.0	0.0
29	1.8	2327.9	0.0	296.9	0.0	0.0	0.0	0.0	0.0
30	1.7	2270.2	0.0	180.1	0.0	0.0	0.0	0.0	0.0
31	1.7	2155.5	0.0	58.9	0.0	0.0	0.0	0.0	0.0
32	0.0	48.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	1.7	2134.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	1.7	2063.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	1.7	1984.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	1.6	1898.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	1.6	1806.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	1.6	1707.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	1.6	1602.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	1.5	1491.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	1.5	1376.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	1.5	1256.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	1.5	1133.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	0.6	408.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.9	577.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	1.4	755.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	1.4	520.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	1.3	290.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	1.1	70.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.89	14.44
2	30.86	14.09
3	32.84	13.79
4	34.82	13.54
5	36.81	13.35
6	38.81	13.21
7	40.80	13.13

8	42.80	13.10
9	44.80	13.12
10	46.80	13.20
11	48.80	13.34
12	50.79	13.53
13	52.77	13.77
14	54.75	14.06
15	56.72	14.41
16	58.68	14.81
17	60.63	15.27
18	62.56	15.78
19	64.48	16.34
20	66.39	16.95
21	68.27	17.62
22	70.14	18.33
23	71.99	19.10
24	73.81	19.91
25	75.62	20.78
26	77.40	21.69
27	79.15	22.65
28	80.88	23.66
29	82.58	24.72
30	84.24	25.82
31	85.88	26.97
32	87.49	28.16
33	89.06	29.39
34	90.60	30.67
35	92.11	31.98
36	93.58	33.34
37	95.01	34.74
38	96.40	36.17
39	97.75	37.65
40	99.07	39.16
41	100.34	40.70
42	101.57	42.28
43	102.75	43.89
44	103.89	45.53
45	104.99	47.21
46	106.04	48.91
47	106.67	50.00

Circle Center At X =   42.9 ; Y =   86.7 and Radius,   73.6

*** 1.344 ***

1

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.22	21.11
2	44.14	20.55
3	46.08	20.07
4	48.04	19.67
5	50.02	19.35
6	52.00	19.10
7	54.00	18.94

8	55.99	18.85
9	57.99	18.84
10	59.99	18.92
11	61.99	19.07
12	63.97	19.30
13	65.95	19.61
14	67.91	20.00
15	69.85	20.47
16	71.78	21.02
17	73.68	21.64
18	75.55	22.33
19	77.40	23.10
20	79.21	23.95
21	80.99	24.86
22	82.73	25.85
23	84.43	26.90
24	86.09	28.02
25	87.70	29.21
26	89.26	30.46
27	90.77	31.77
28	92.23	33.14
29	93.63	34.57
30	94.97	36.05
31	96.26	37.58
32	97.48	39.17
33	98.63	40.80
34	99.72	42.47
35	100.75	44.19
36	101.70	45.95
37	102.58	47.75
38	103.40	49.57
39	103.56	50.00

Circle Center At X = 57.2 ; Y = 69.0 and Radius, 50.1

*** 1.387 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.22	21.11
2	44.13	20.51
3	46.06	20.00
4	48.02	19.57
5	49.99	19.23
6	51.97	18.98
7	53.96	18.81
8	55.96	18.74
9	57.96	18.76
10	59.96	18.86
11	61.95	19.06
12	63.93	19.35
13	65.90	19.72
14	67.84	20.18
15	69.77	20.73
16	71.66	21.36

17	73.53	22.08
18	75.36	22.88
19	77.16	23.76
20	78.91	24.72
21	80.62	25.76
22	82.28	26.87
23	83.89	28.06
24	85.44	29.32
25	86.94	30.65
26	88.38	32.04
27	89.75	33.50
28	91.05	35.01
29	92.29	36.58
30	93.45	38.21
31	94.54	39.89
32	95.56	41.61
33	96.49	43.38
34	97.35	45.19
35	98.12	47.03
36	98.81	48.91
37	99.00	49.50

Circle Center At X = 56.6 ; Y = 63.4 and Radius, 44.6

*** 1.411 ***

1

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.63	22.95
3	50.60	22.62
4	52.59	22.36
5	54.58	22.16
6	56.57	22.02
7	58.57	21.95
8	60.57	21.94
9	62.57	22.00
10	64.57	22.11
11	66.56	22.29
12	68.54	22.54
13	70.52	22.84
14	72.48	23.21
15	74.44	23.64
16	76.38	24.14
17	78.30	24.69
18	80.20	25.31
19	82.08	25.98
20	83.94	26.71
21	85.78	27.51
22	87.59	28.36
23	89.37	29.26
24	91.13	30.23
25	92.85	31.25
26	94.53	32.32

27	96.19	33.44
28	97.80	34.62
29	99.38	35.85
30	100.92	37.13
31	102.42	38.45
32	103.87	39.83
33	105.29	41.24
34	106.65	42.70
35	107.97	44.21
36	109.24	45.75
37	110.46	47.34
38	111.63	48.96
39	112.33	50.00

Circle Center At X = 59.9 ; Y = 85.0 and Radius, 63.1

*** 1.414 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.89	14.44
2	30.87	14.20
3	32.87	14.01
4	34.86	13.89
5	36.86	13.84
6	38.86	13.85
7	40.86	13.93
8	42.85	14.08
9	44.84	14.29
10	46.82	14.56
11	48.80	14.90
12	50.75	15.31
13	52.70	15.78
14	54.63	16.31
15	56.53	16.91
16	58.42	17.57
17	60.29	18.29
18	62.13	19.07
19	63.94	19.91
20	65.73	20.81
21	67.49	21.77
22	69.21	22.78
23	70.90	23.85
24	72.55	24.98
25	74.16	26.16
26	75.74	27.39
27	77.27	28.68
28	78.76	30.01
29	80.21	31.39
30	81.61	32.82
31	82.96	34.30
32	84.26	35.81
33	85.51	37.37
34	86.72	38.97
35	87.86	40.61

36	88.95	42.29
37	89.99	44.00
38	90.77	45.39

Circle Center At X =   37.5 ; Y =   74.7 and Radius,   60.8

*** 1.430 ***

1

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.44	12.22
2	26.41	11.87
3	28.39	11.58
4	30.38	11.35
5	32.37	11.17
6	34.37	11.04
7	36.37	10.98
8	38.37	10.97
9	40.37	11.02
10	42.36	11.12
11	44.36	11.28
12	46.34	11.50
13	48.33	11.77
14	50.30	12.10
15	52.26	12.49
16	54.21	12.93
17	56.15	13.42
18	58.07	13.98
19	59.98	14.58
20	61.87	15.24
21	63.73	15.95
22	65.58	16.72
23	67.41	17.54
24	69.21	18.41
25	70.98	19.33
26	72.73	20.30
27	74.45	21.31
28	76.15	22.38
29	77.81	23.50
30	79.43	24.66
31	81.03	25.87
32	82.59	27.12
33	84.11	28.42
34	85.60	29.75
35	87.04	31.13
36	88.45	32.56
37	89.82	34.02
38	91.14	35.51
39	92.42	37.05
40	93.66	38.62
41	94.85	40.23
42	96.00	41.87
43	97.10	43.54
44	98.15	45.24

45	99.15	46.97
46	100.11	48.73
47	100.75	50.00

Circle Center At X =   37.7 ; Y =   81.4 and Radius,   70.5

*** 1.431 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.57	22.72
3	50.51	22.24
4	52.48	21.89
5	54.47	21.67
6	56.47	21.58
7	58.47	21.63
8	60.46	21.82
9	62.43	22.14
10	64.38	22.59
11	66.29	23.17
12	68.16	23.88
13	69.98	24.71
14	71.74	25.66
15	73.43	26.73
16	75.05	27.91
17	76.58	29.20
18	78.02	30.59
19	79.36	32.07
20	80.61	33.63
21	81.74	35.28
22	82.76	37.00
23	83.66	38.79
24	84.44	40.63
25	85.10	42.52
26	85.11	42.55

Circle Center At X =   56.7 ; Y =   51.3 and Radius,   29.7

*** 1.435 ***

1

Failure Surface Specified By 53 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.89	14.44
2	30.87	14.15
3	32.85	13.90

4	34.84	13.69
5	36.83	13.52
6	38.83	13.39
7	40.83	13.30
8	42.83	13.25
9	44.83	13.24
10	46.83	13.27
11	48.83	13.34
12	50.82	13.45
13	52.82	13.61
14	54.81	13.80
15	56.79	14.03
16	58.78	14.30
17	60.75	14.61
18	62.72	14.97
19	64.68	15.36
20	66.63	15.79
21	68.58	16.26
22	70.51	16.77
23	72.43	17.32
24	74.35	17.90
25	76.25	18.53
26	78.13	19.19
27	80.01	19.89
28	81.86	20.63
29	83.71	21.41
30	85.53	22.22
31	87.34	23.07
32	89.14	23.96
33	90.91	24.88
34	92.67	25.84
35	94.40	26.84
36	96.12	27.87
37	97.81	28.93
38	99.48	30.03
39	101.13	31.16
40	102.76	32.32
41	104.36	33.52
42	105.94	34.74
43	107.50	36.00
44	109.02	37.29
45	110.52	38.62
46	112.00	39.97
47	113.45	41.35
48	114.86	42.76
49	116.25	44.20
50	117.61	45.66
51	118.94	47.16
52	120.24	48.67
53	121.33	50.00

Circle Center At X = 44.3 ; Y = 112.3 and Radius, 99.1

*** 1.442 ***

Failure Surface Specified By 29 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	46.67	23.33
2	48.51	22.56
3	50.40	21.91
4	52.33	21.38
5	54.29	20.97
6	56.27	20.69
7	58.26	20.54
8	60.26	20.52
9	62.26	20.62
10	64.25	20.85
11	66.22	21.20
12	68.16	21.68
13	70.06	22.29
14	71.93	23.01
15	73.74	23.85
16	75.50	24.81
17	77.19	25.88
18	78.81	27.05
19	80.35	28.32
20	81.81	29.69
21	83.18	31.15
22	84.45	32.70
23	85.62	34.32
24	86.68	36.01
25	87.64	37.77
26	88.48	39.58
27	89.20	41.45
28	89.80	43.36
29	90.24	45.12

Circle Center At X =   59.7 ; Y =   51.8 and Radius,   31.3

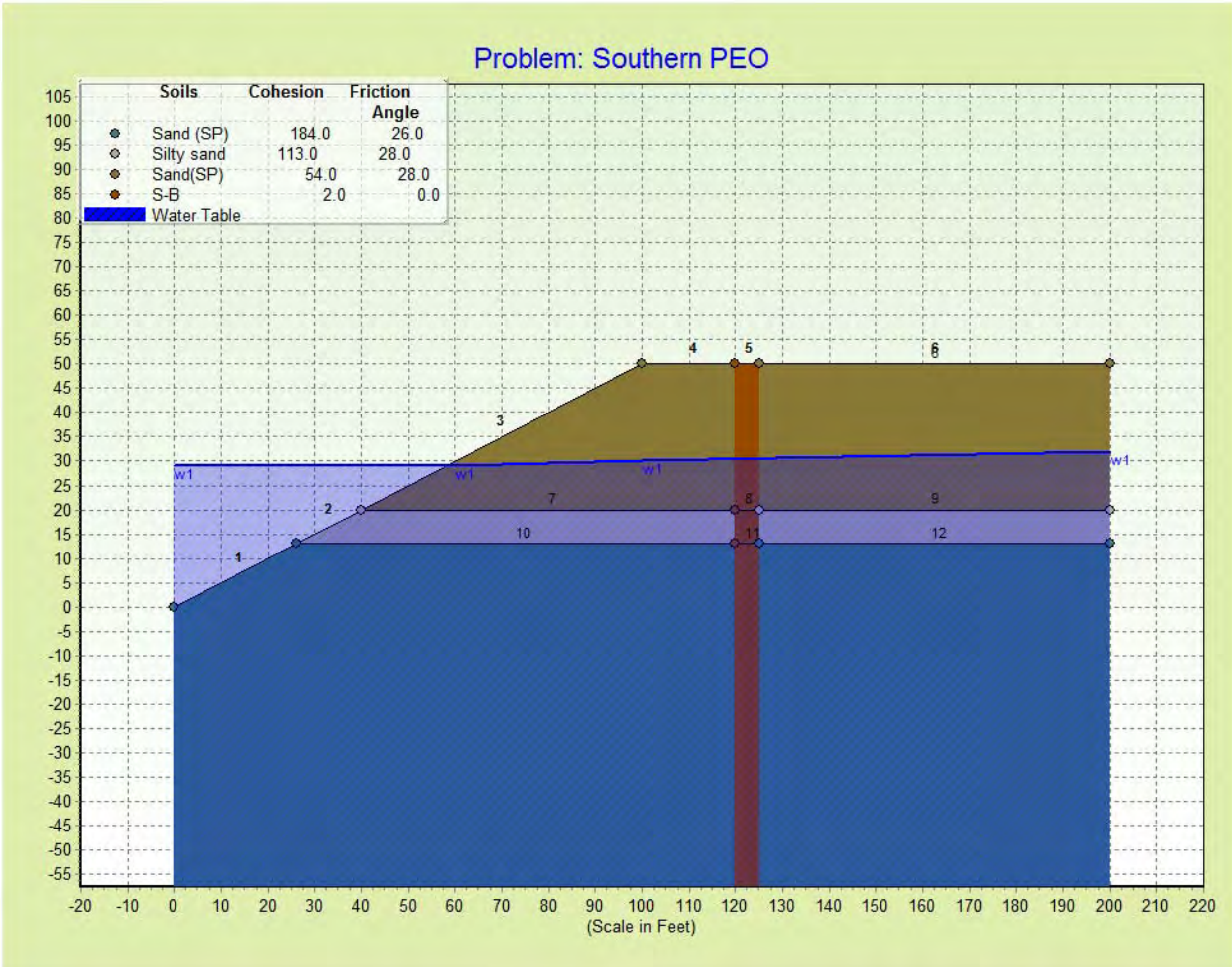
***   1.451   ***

1

```
           Y            A     X     I     S            F     T

           0.00     25.00     50.00     75.00    100.00    125.00

X      0.00 *---------+-W-------+---------+---------+---------+
            -
            -
            -
            -
            -   .
      25.00 + ...*
            - ...71
            -...721.
            -...721..
            -...721.*
            -....21.35
A     50.00 +....26135.
            .....72135..
            ......2115..W
            ......2215....
            ......92318....
```

```
                .......2211....
X      75.00 .......923118...
             ........923166...
             ........9923166888
             .........992211666.
             ..........9.2211.06.
             -..........99522144.
I     100.00 +..........W.552114*
             -............9955.111
             - ............99.55 2
             -  ............999.55
             -   .............99..
             -    *..*..........9*
S     125.00 +    *..*...........*
             -        .............
             -         ............
             -            .........
             -               ......
             -                  ...
      150.00 +
             -
             -
             -
             -
             -
F     175.00 +
             -
             -
             -
             -
             -
T     200.00 +    *  *    W      *
```

================== DATA SUMMARY ====================



Profile Data

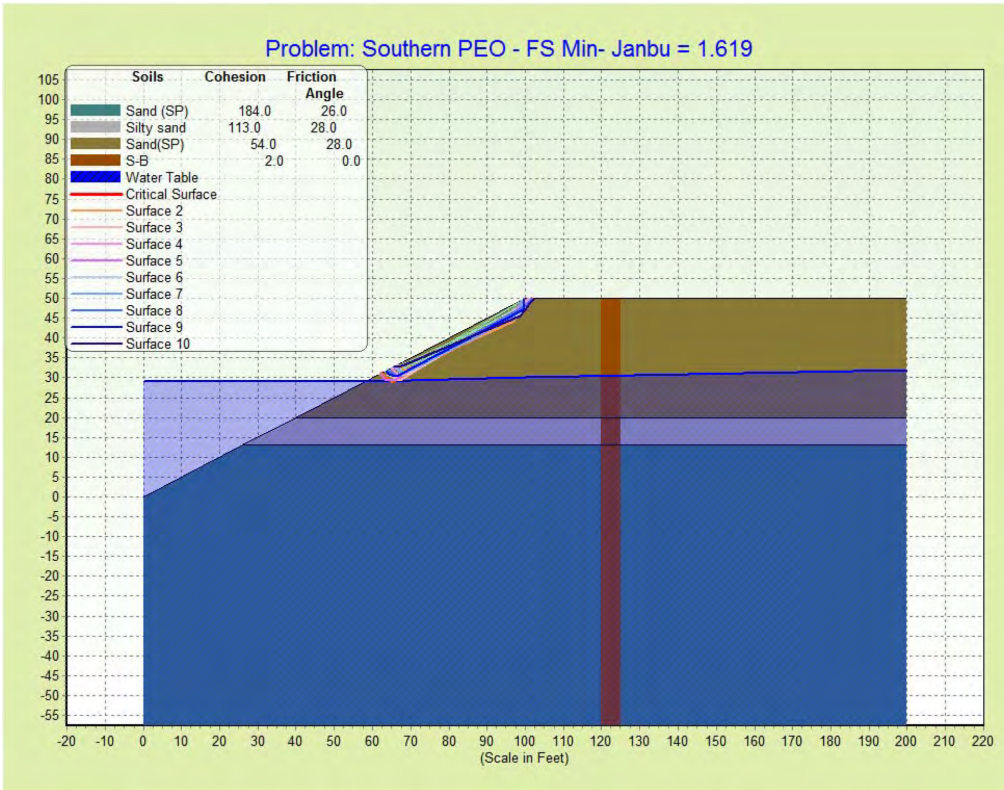
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

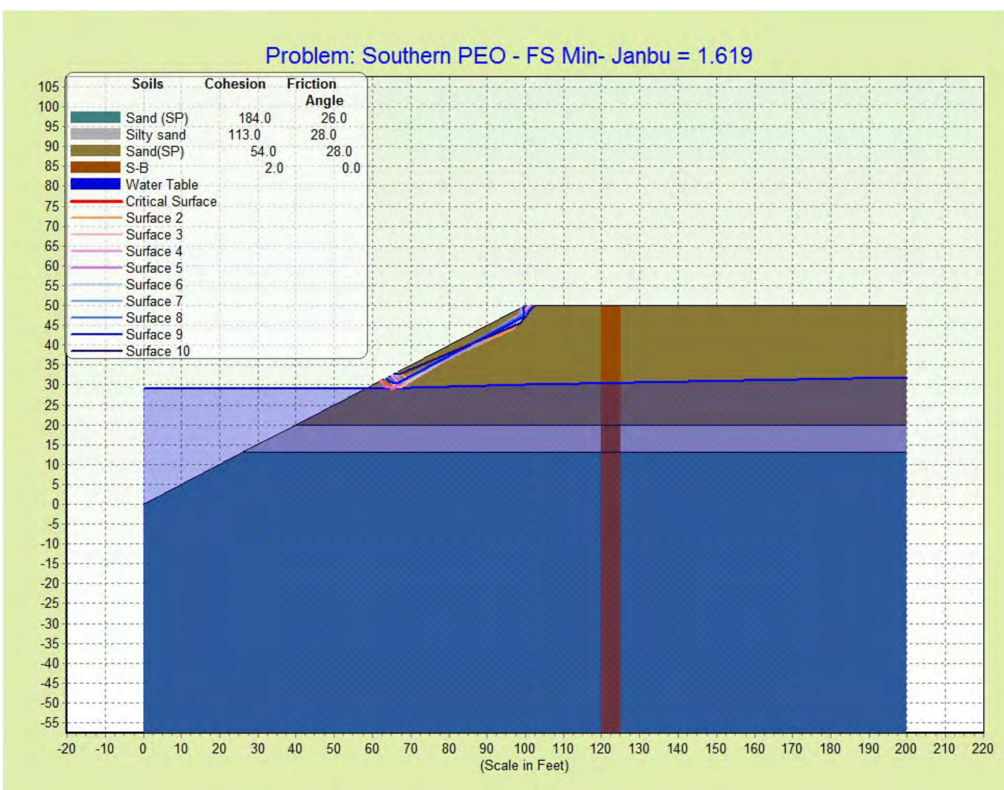
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	100.00	30.00
4	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

20 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 2.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	65.00	30.00	70.00	33.00	4.00
2	95.00	45.00	100.00	48.00	4.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	62.27	31.14

2	63.54	30.01
3	65.26	28.99
4	98.43	46.02
5	99.56	47.67
6	100.97	49.09
7	101.64	50.00

*** 1.619 ***

Individual data on the 9 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.3	124.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5	427.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.2	90.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0
4	0.3	117.3	0.0	1.4	0.0	0.0	0.0	0.0	0.0
5	32.9	12461.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.1	332.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.4	97.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.7	33.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.44	33.22
2	67.07	32.95
3	68.75	31.87
4	97.06	44.28
5	98.02	46.04
6	99.09	47.73
7	100.35	49.28
8	100.92	50.00

*** 1.624 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.34	31.67
2	63.82	31.42
3	65.33	30.10
4	67.18	29.35
5	99.79	48.34

6	101.20	49.75
7	101.33	50.00

*** 1.702 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	64.77	32.39
2	65.71	31.80
3	67.18	30.44
4	98.78	46.32
5	99.48	48.19
6	100.88	49.61
7	100.92	50.00

*** 1.704 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	61.95	30.97
2	62.12	30.82
3	63.54	29.41
4	65.54	29.36
5	97.59	46.85
6	98.65	48.54
7	99.00	49.50

*** 1.708 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.54	32.77
2	66.45	32.08
3	67.87	30.67
4	99.37	46.73
5	100.78	48.15
6	101.57	49.99
7	101.59	50.00

*** 1.710 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.63	32.82
2	66.53	32.38
3	67.95	30.96
4	96.20	44.70
5	97.61	46.12
6	98.74	47.77
7	98.88	49.44

*** 1.712 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.82	31.91
2	64.77	31.40
3	66.42	30.27
4	99.78	47.79
5	101.07	49.32
6	101.71	50.00

*** 1.729 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.44	31.72
2	64.43	30.94
3	66.34	30.35
4	99.34	47.08
5	99.69	49.05
6	99.74	49.87

*** 1.734 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.36	32.68
2	67.01	32.61
3	98.73	45.67
4	99.99	47.23
5	101.21	48.81
6	102.37	50.00

```
          ***      1.742   ***
```

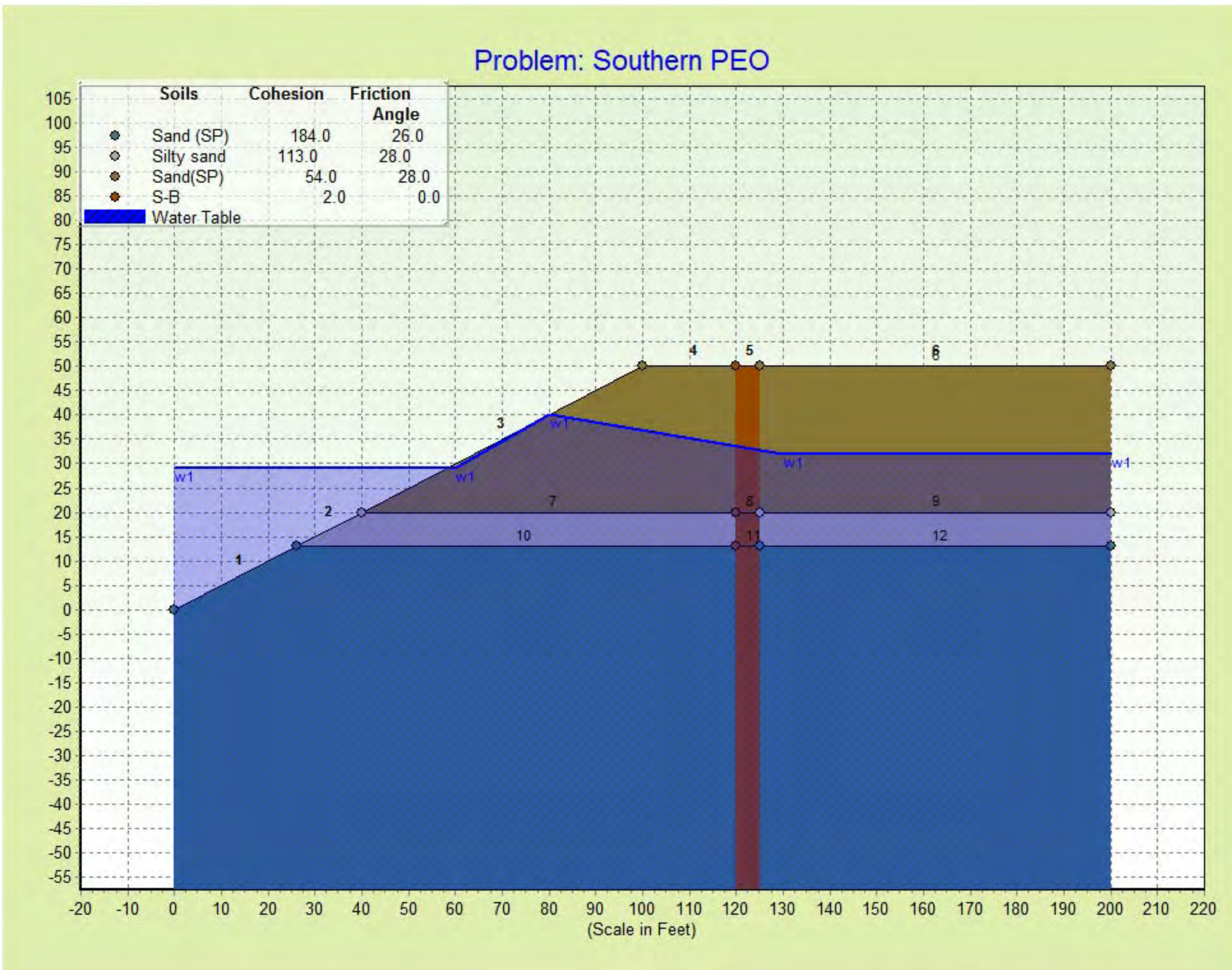
1

```
                 Y           A     X     I     S           F     T

                 0.00     25.00     50.00     75.00    100.00    125.00

 X      0.00 *---------+-W-------+---------+---------+---------+
             -
             -
             -
             -
             -
      25.00 +    *
             -
             -
             -
             -       *
             -
 A      50.00 +
             -
             -           W
             -           13
             -           12.
             -           .2
 X      75.00 +
             -
             -
             -
             -
             -                 25
 I     100.00 +           W     11*
             -                   0
             -
             -
             -
             -    *  *            *
 S     125.00 +    *  *            *
             -
             -
             -
```

```
                -
                -
     150.00 +
                -
                -
                -
                -
                -
F    175.00 +
                -
                -
                -
                -
                -
T    200.00 +     *   *     W       *
```

Appendix C.6
Post-Construction, Rapid Drawdown Condition

================== DATA SUMMARY ====================



Profile Data

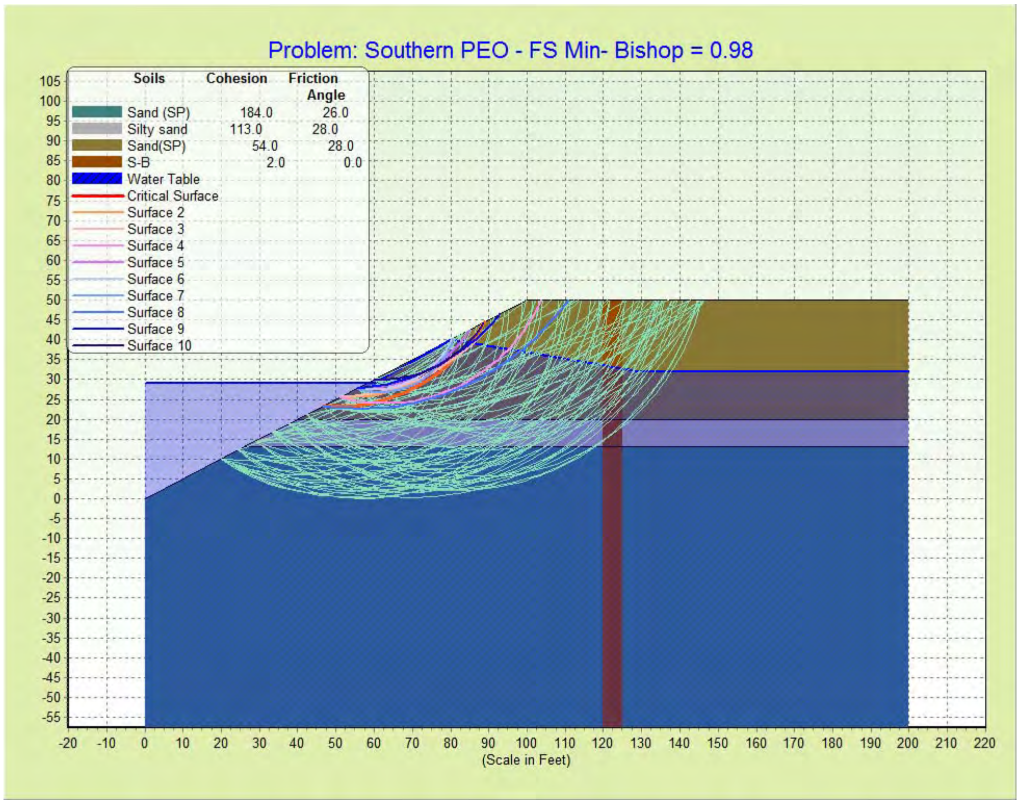
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

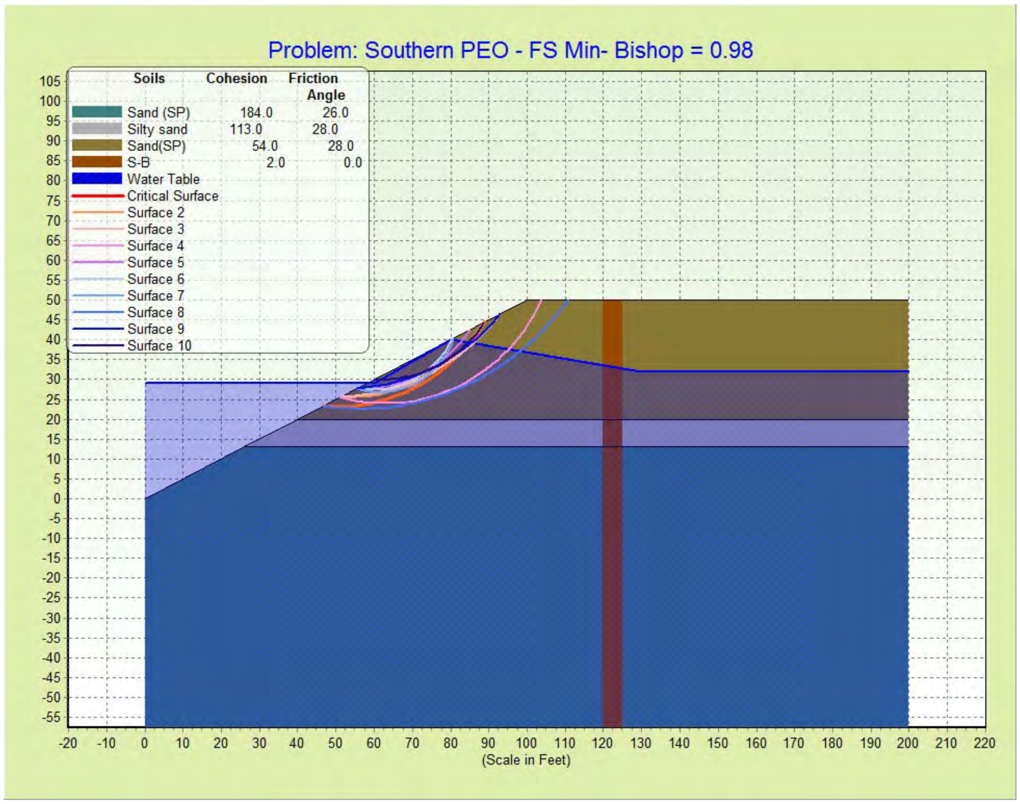
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions
1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	80.00	40.00
4	130.00	32.00
5	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 20.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 80.00 ft.
and X = 147.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.66	23.21
3	50.66	23.18
4	52.66	23.24
5	54.66	23.38
6	56.64	23.61
7	58.62	23.93
8	60.58	24.34
9	62.52	24.83
10	64.43	25.41
11	66.32	26.07
12	68.18	26.81
13	70.00	27.63
14	71.78	28.54
15	73.53	29.52
16	75.22	30.57
17	76.87	31.71
18	78.47	32.91
19	80.02	34.18
20	81.50	35.52
21	82.93	36.92
22	84.29	38.38
23	85.59	39.90
24	86.82	41.48
25	87.98	43.11
26	88.82	44.41

Circle Center At X = 50.4 ; Y = 68.6 and Radius, 45.4

*** 0.980 ***

Individual data on the 28 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.0	131.7	719.7	714.6	0.0	0.0	0.0	0.0	0.0
2	2.0	385.5	581.5	724.1	0.0	0.0	0.0	0.0	0.0
3	2.0	618.4	441.9	722.6	0.0	0.0	0.0	0.0	0.0
4	2.0	828.4	302.0	710.1	0.0	0.0	0.0	0.0	0.0
5	2.0	1014.2	162.8	686.6	0.0	0.0	0.0	0.0	0.0
6	2.0	1174.5	25.4	652.2	0.0	0.0	0.0	0.0	0.0
7	1.4	903.1	0.0	433.5	0.0	0.0	0.0	0.0	0.0
8	0.6	392.7	0.0	158.5	0.0	0.0	0.0	0.0	0.0
9	1.9	1394.7	0.0	580.8	0.0	0.0	0.0	0.0	0.0
10	1.9	1475.3	0.0	638.8	0.0	0.0	0.0	0.0	0.0
11	1.9	1528.9	0.0	685.9	0.0	0.0	0.0	0.0	0.0
12	1.9	1556.1	0.0	722.1	0.0	0.0	0.0	0.0	0.0
13	1.8	1557.4	0.0	747.4	0.0	0.0	0.0	0.0	0.0
14	1.8	1533.9	0.0	761.5	0.0	0.0	0.0	0.0	0.0
15	1.7	1486.9	0.0	764.6	0.0	0.0	0.0	0.0	0.0
16	1.7	1418.0	0.0	756.7	0.0	0.0	0.0	0.0	0.0
17	1.6	1329.1	0.0	737.6	0.0	0.0	0.0	0.0	0.0
18	1.6	1222.2	0.0	707.5	0.0	0.0	0.0	0.0	0.0

19	1.5	1088.8	0.0	659.8	0.0	0.0	0.0	0.0	0.0
20	0.0	11.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0
21	1.5	964.7	0.0	620.1	0.0	0.0	0.0	0.0	0.0
22	1.4	808.2	0.0	422.6	0.0	0.0	0.0	0.0	0.0
23	1.4	645.6	0.0	218.5	0.0	0.0	0.0	0.0	0.0
24	0.7	276.2	0.0	30.9	0.0	0.0	0.0	0.0	0.0
25	0.6	205.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	1.2	328.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	1.2	180.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.8	40.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.50
3	55.11	25.55
4	57.11	25.68
5	59.09	25.91
6	61.07	26.24
7	63.02	26.65
8	64.96	27.16
9	66.87	27.76
10	68.74	28.45
11	70.59	29.22
12	72.39	30.08
13	74.15	31.03
14	75.87	32.06
15	77.54	33.16
16	79.15	34.35
17	80.70	35.61
18	82.19	36.94
19	83.62	38.34
20	84.98	39.80
21	86.28	41.33
22	87.49	42.92
23	88.38	44.19

Circle Center At X = 53.2 ; Y = 68.0 and Radius, 42.4

*** 0.987 ***

1

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.11	25.65
3	55.10	25.81
4	57.09	26.05
5	59.06	26.36
6	61.03	26.74
7	62.98	27.19

8	64.91	27.71
9	66.82	28.29
10	68.71	28.95
11	70.57	29.68
12	72.41	30.47
13	74.22	31.32
14	75.99	32.24
15	77.73	33.23
16	79.44	34.27
17	81.11	35.38
18	82.73	36.55
19	84.31	37.77
20	85.85	39.05
21	87.34	40.38
22	88.78	41.77
23	90.17	43.21
24	91.51	44.69
25	92.79	46.23
26	93.01	46.50

Circle Center At X =   49.5 ; Y =   81.1 and Radius,   55.6

*** 1.010 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	51.11	25.56
2	53.05	25.08
3	55.01	24.68
4	56.99	24.38
5	58.98	24.16
6	60.98	24.03
7	62.97	23.99
8	64.97	24.04
9	66.97	24.18
10	68.96	24.40
11	70.93	24.72
12	72.89	25.12
13	74.83	25.61
14	76.75	26.18
15	78.64	26.83
16	80.50	27.57
17	82.32	28.40
18	84.10	29.30
19	85.85	30.28
20	87.55	31.33
21	89.20	32.46
22	90.79	33.66
23	92.34	34.94
24	93.82	36.27
25	95.25	37.68
26	96.61	39.14
27	97.91	40.67
28	99.13	42.25
29	100.29	43.88

30	101.37	45.56
31	102.37	47.29
32	103.30	49.06
33	103.74	50.00

Circle Center At X = 62.9 ; Y = 69.1 and Radius, 45.1

*** 1.040 ***

1

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.56	27.76
3	59.55	27.86
4	61.54	28.08
5	63.51	28.41
6	65.46	28.86
7	67.38	29.42
8	69.27	30.09
9	71.11	30.87
10	72.90	31.76
11	74.64	32.75
12	76.32	33.83
13	77.93	35.02
14	79.47	36.29
15	80.94	37.66
16	82.32	39.10
17	83.61	40.63
18	84.82	42.22
19	85.00	42.50

Circle Center At X = 56.8 ; Y = 62.1 and Radius, 34.3

*** 1.044 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.54	27.52
3	59.54	27.42
4	61.54	27.50
5	63.52	27.76
6	65.47	28.18
7	67.39	28.76
8	69.24	29.51
9	71.03	30.41

10	72.73	31.47
11	74.33	32.66
12	75.83	33.99
13	77.20	35.44
14	78.45	37.00
15	79.56	38.67
16	80.40	40.20

Circle Center At X = 59.6 ; Y = 50.7 and Radius, 23.3

*** 1.070 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.49	27.27
3	59.46	26.95
4	61.46	26.83
5	63.46	26.91
6	65.44	27.18
7	67.38	27.65
8	69.27	28.31
9	71.09	29.15
10	72.81	30.17
11	74.42	31.35
12	75.91	32.69
13	77.26	34.17
14	78.45	35.77
15	79.48	37.49
16	80.34	39.29
17	80.72	40.36

Circle Center At X = 61.7 ; Y = 47.0 and Radius, 20.2

*** 1.070 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	23.33
2	48.65	23.07
3	50.64	22.87
4	52.63	22.73
5	54.63	22.64
6	56.63	22.62
7	58.63	22.65
8	60.63	22.75

9	62.62	22.90
10	64.61	23.11
11	66.59	23.38
12	68.57	23.71
13	70.53	24.10
14	72.48	24.55
15	74.42	25.05
16	76.34	25.61
17	78.24	26.23
18	80.12	26.90
19	81.98	27.63
20	83.82	28.41
21	85.64	29.25
22	87.43	30.14
23	89.19	31.08
24	90.93	32.08
25	92.63	33.12
26	94.31	34.22
27	95.95	35.36
28	97.55	36.56
29	99.12	37.80
30	100.65	39.08
31	102.15	40.41
32	103.60	41.79
33	105.01	43.20
34	106.38	44.66
35	107.70	46.16
36	108.99	47.70
37	110.22	49.27
38	110.76	50.00

Circle Center At X = 56.5 ; Y = 90.1 and Radius, 67.5

*** 1.076 ***

1

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.56	27.78
2	57.55	27.94
3	59.54	28.18
4	61.51	28.49
5	63.47	28.87
6	65.42	29.33
7	67.35	29.86
8	69.26	30.46
9	71.14	31.13
10	73.00	31.87
11	74.83	32.68
12	76.62	33.56
13	78.39	34.51
14	80.11	35.51
15	81.80	36.59
16	83.45	37.72
17	85.05	38.92

18	86.61	40.17
19	88.12	41.49
20	89.58	42.85
21	90.98	44.28
22	92.34	45.75
23	92.96	46.48

Circle Center At X =   52.2 ; Y =   81.3 and Radius,   53.6

***   1.077   ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	60.00	30.00
2	62.00	29.94
3	64.00	30.00
4	65.99	30.19
5	67.97	30.50
6	69.92	30.93
7	71.84	31.49
8	73.72	32.17
9	75.56	32.96
10	77.34	33.87
11	79.06	34.88
12	80.72	36.00
13	82.30	37.23
14	83.80	38.55
15	85.22	39.96
16	86.54	41.46
17	87.77	43.04
18	88.65	44.33

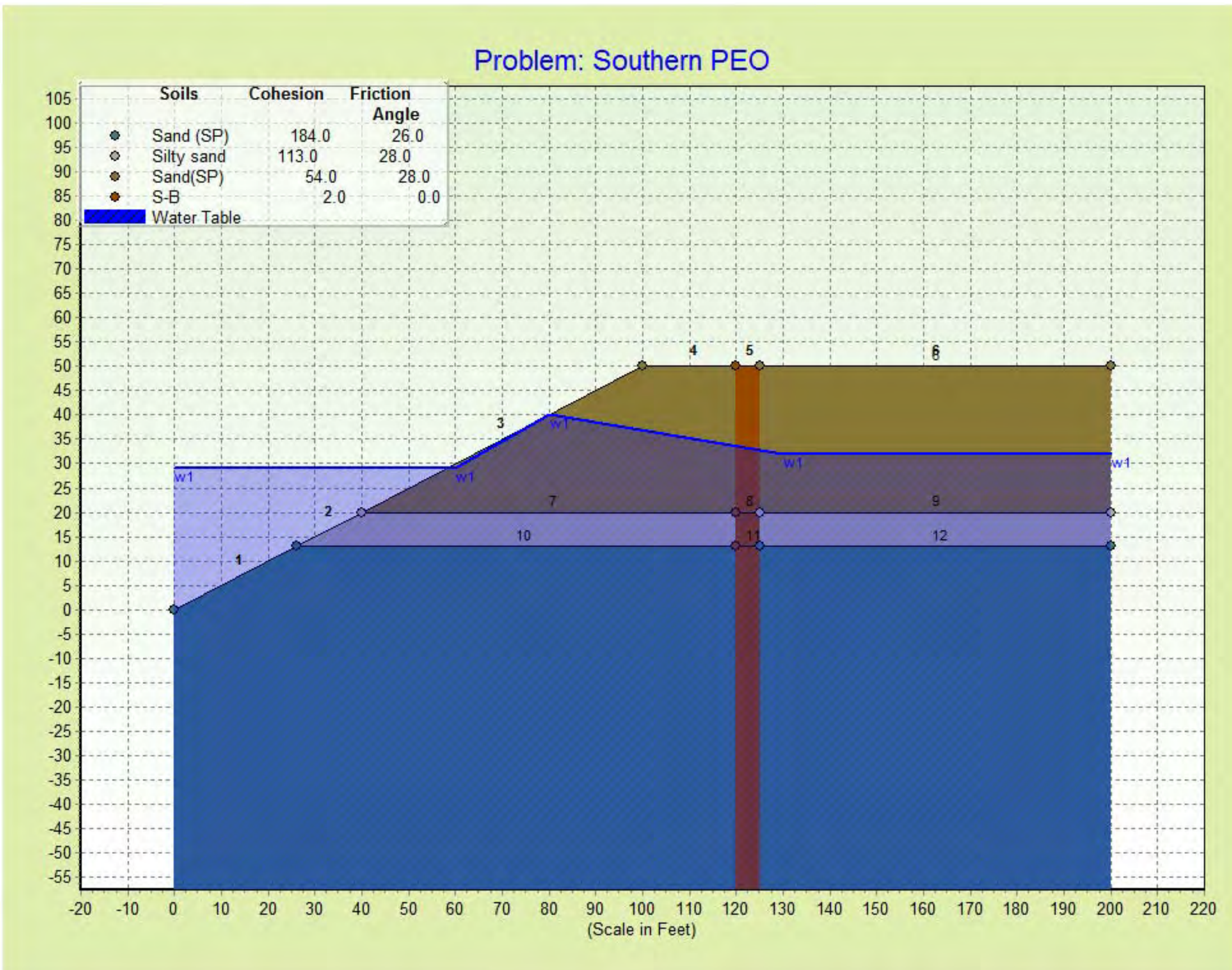
Circle Center At X =   62.0 ; Y =   61.8 and Radius,   31.9

***   1.092   ***

```
1

                 Y            A     X     I     S           F     T

                 0.00     25.00     50.00     75.00    100.00    125.00

X      0.00 *---------+-W-------+---------+---------+---------+
            -
            -
            -
            -
            -    .
      25.00 + ...*
            - .....
            -.......
```

```
                -........
                -.......*
                .........1
A      50.00 .........12
                .........125
                .........113W
                .........8129.
                .........8113.
                ..........4125.
X      75.00 ..........4.115.
                ..........84.115W
                -..........44.1125
                -...........44..111
                -............44..333
                -.............844...
I     100.00 + .............8844.*
                - ..............88.44
                -  ...............888
                -   ................8
                -    ................
                -    *..*...........*
S     125.00 +    * .*...........*
                -       .....W.......
                -         ...........
                -           .........
                -              ......
                -                 ...
      150.00 +
                -
                -
                -
                -
                -
F     175.00 +
                -
                -
                -
                -
                -
T     200.00 +    *  *    W       *
```

================== DATA SUMMARY ====================



Profile Data

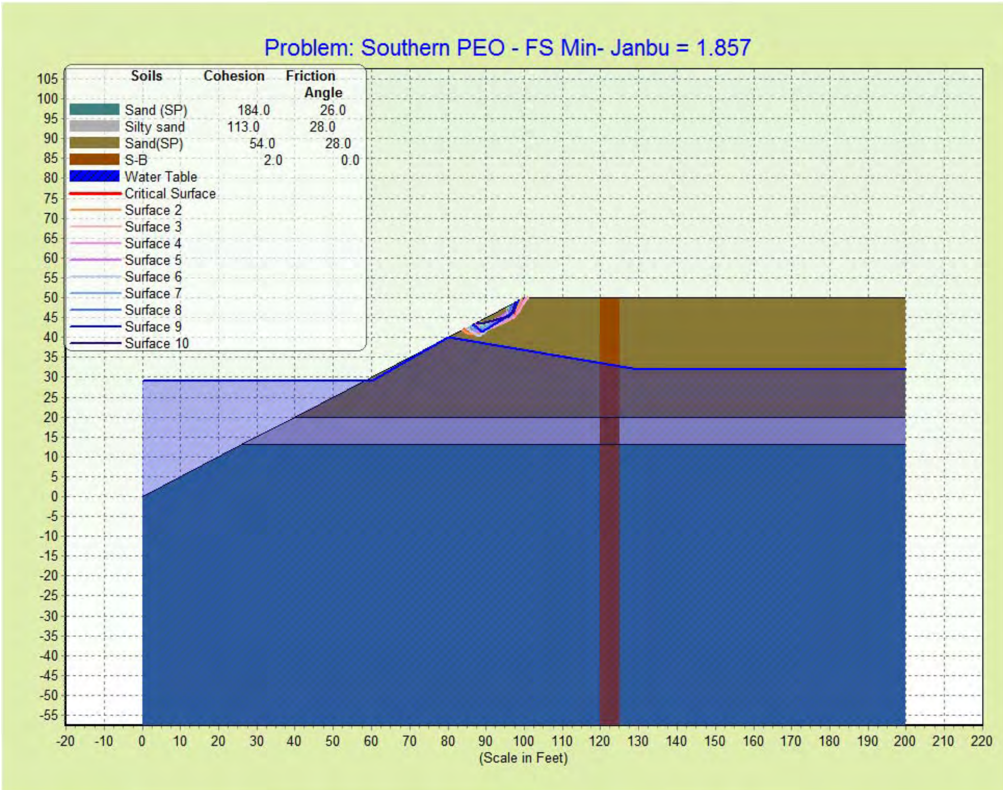
Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
1	0	0	26	13	3
2	26	13	40	20	2
3	40	20	100	50	1
4	100	50	120	50	1
5	120	50	125	50	4
6	125	50	200	50	1
7	40	20	120	20	2
8	120	20	125	20	4
9	125	20	200	20	2
10	26	13	120	13	3

Segment Number	Left Extreme X	Left Extreme Y	Right Extreme X	Right Extreme Y	Soil Under Segment
11	120	13	125	13	4
12	125	13	200	13	3

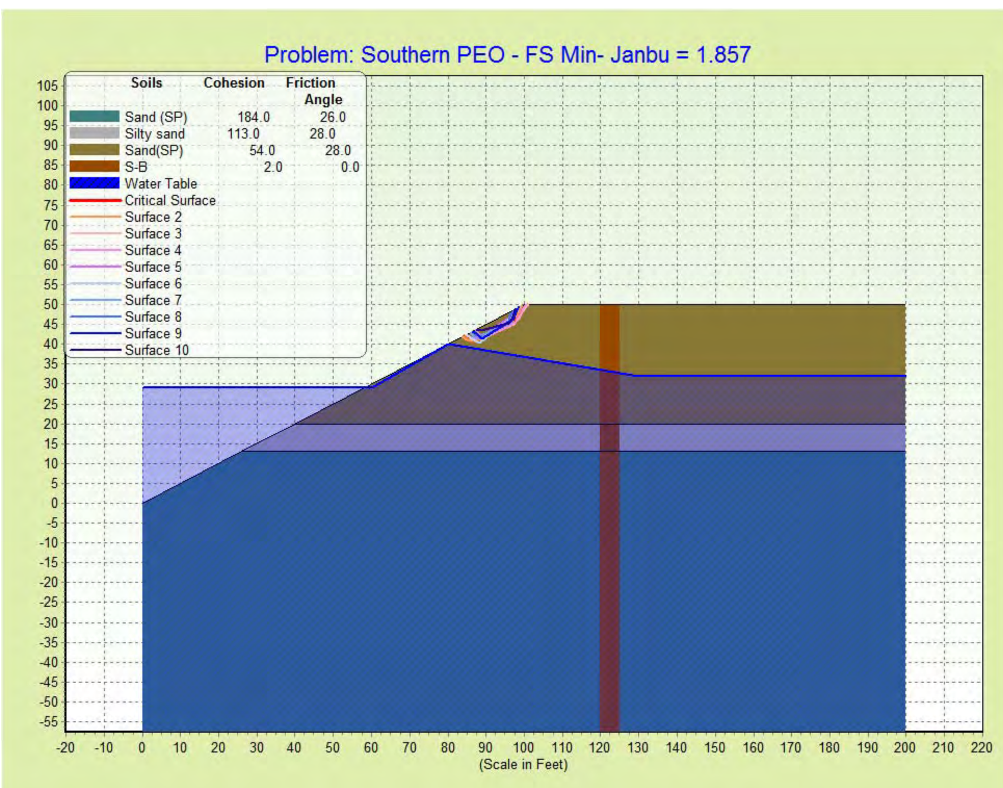
Soil Properties

Soil Number	Wet Unit Weight	Saturated Unit Weight	Cohesive Intercept	Friction Angle	Ru	Pressure Head	Water Table	Soil Name
1	111	118	54	28	0	0	1	Sand(SP)
2	110	115	113	28	0	0	1	Silty sand
3	117	125	184	26	0	0	1	Sand (SP)
4	110	120	2	0	0	0	1	S-B

=============== All Surfaces Generated =============



=============== 10 Most Critical Surfaces ===============



** STABL for WINDOWS **
by
Geotechnical Software Solutions

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: U.S.C.
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Southern PEO

BOUNDARY COORDINATES

6 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	26.00	13.00	3
2	26.00	13.00	40.00	20.00	2
3	40.00	20.00	100.00	50.00	1
4	100.00	50.00	120.00	50.00	1
5	120.00	50.00	125.00	50.00	4
6	125.00	50.00	200.00	50.00	1
7	40.00	20.00	120.00	20.00	2
8	120.00	20.00	125.00	20.00	4
9	125.00	20.00	200.00	20.00	2
10	26.00	13.00	120.00	13.00	3
11	120.00	13.00	125.00	13.00	4
12	125.00	13.00	200.00	13.00	3

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	111.0	118.0	54.0	28.0	0.00	0.0	1
2	110.0	115.0	113.0	28.0	0.00	0.0	1

3	117.0	125.0	184.0	26.0	0.00	0.0	1
4	110.0	120.0	2.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	29.00
2	60.00	29.00
3	80.00	40.00
4	130.00	32.00
5	200.00	32.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

20 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is   2.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	87.00	41.00	90.00	43.00	3.00
2	95.00	45.00	98.00	47.00	3.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	84.17	42.09
2	85.18	41.19
3	87.15	40.83
4	96.72	45.36
5	98.13	46.78
6	99.34	48.37
7	100.75	49.79
8	100.84	50.00

*** 1.857 ***

Individual data on the 8 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	78.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0	452.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	9.6	3054.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.4	414.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.2	241.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.7	83.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.7	49.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	83.62	41.81
2	85.10	41.02
3	87.10	40.89
4	96.31	44.40
5	97.06	46.26
6	98.37	47.76
7	99.32	49.53
8	99.58	49.79

*** 1.934 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.78	42.89
2	86.00	42.79
3	87.47	41.42
4	97.24	45.15

5	98.59	46.63
6	99.61	48.35
7	100.94	49.85
8	101.05	50.00

*** 1.974 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.21	43.60
2	88.10	42.79
3	89.77	41.68
4	97.74	45.47
5	98.72	47.22
6	99.86	48.86
7	100.53	50.00

*** 2.069 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.89	42.45
2	86.12	41.58
3	88.11	41.47
4	96.66	47.23
5	97.80	48.88
6	97.84	48.92

*** 2.136 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.78	42.39
2	84.79	42.39
3	86.48	41.32
4	88.24	40.36
5	96.56	46.64
6	97.80	48.21

7	98.34	49.17

*** 2.149 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	85.78	42.89
2	87.08	41.64
3	96.44	45.28
4	97.04	47.19
5	98.44	48.62
6	98.73	49.37

*** 2.264 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.53	43.27
2	87.53	42.40
3	89.38	41.64
4	95.92	45.81
5	96.59	47.70
6	97.77	48.88

*** 2.299 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.49	43.24
2	87.36	42.64
3	88.82	41.27
4	97.21	46.41
5	97.89	48.29
6	98.70	49.35

*** 2.334 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.42	43.71
2	88.69	43.46
3	95.80	45.19
4	97.06	46.75
5	97.65	48.66
6	97.87	48.93

***   2.340   ***

```
1
                  Y            A      X      I      S            F      T

                  0.00     25.00     50.00     75.00    100.00    125.00
X       0.00 *---------+-W-------+---------+---------+---------+
             -
             -
             -
             -
             -
       25.00 +    *
             -
             -
             -
             -       *
             -
A      50.00 +
             -
             -           W
             -
             -
             -
X      75.00 +
             -               W
             -               11
             -               13.
             -                4
             -                 125
I     100.00 +                  1*
             -
             -
             -
             -
             -    *  *           *
S     125.00 +    *  *           *
             -            W
             -
             -
```

```
                   -
                   -
         150.00 +
                   -
                   -
                   -
                   -
                   -
F        175.00 +
                   -
                   -
                   -
                   -
                   -
T        200.00 +     *   *     W       *
```

Appendix D
Photographs of OPT and Conventional Slurry Wall Construction

CONVENTIONAL SLURRY WALL CONSTRUCTION

ONE-PASS SLURRY WALL CONSTRUCTION

ONE-PASS SLURRY WALL CONSTRUCTION

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

Attachment E
Initial Compatibility Test Report
(54 Day)

THIS PAGE INTENTIONALLY LEFT BLANK

SUMMARY OF FLEX WALL COMPATIBILITY TEST RESULTS

ASTM D-7100 and EPA 9100 Compatibility Testing

JLT

Client :	ERM	Print Date :	09/18/2015
Project Location :	Southern Premiere Edible Oils	Job No. :	15LS3238.02
Description :	Mix CB1-5 percent	Tested By :	MLB
Start Date :	07/27/2015	Checked By :	JBJr
Mix Moisture Content	47.46 %	Panel No :	3
Fines Content :	23.1 %	Spec. Gravity :	2.69 Assumed

Physical Property Data

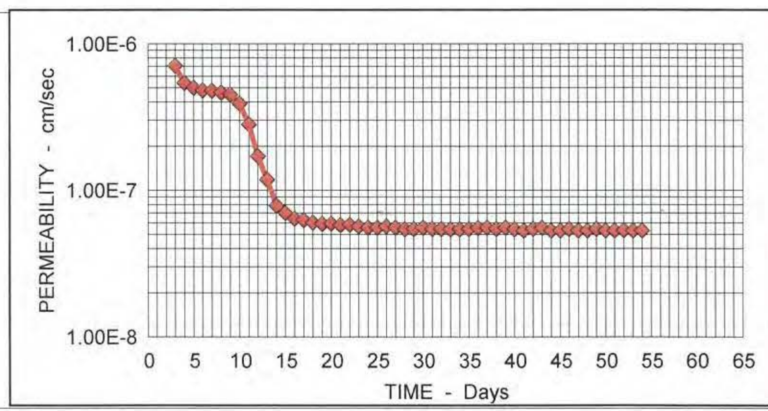
Initial Height (in) :	3.80	Final Height (in) :	[redacted]
Initial Diameter (in) :	2.80	Final Diameter (in) :	[redacted]
Initial Wet Weight (g) :	670.40	Final Wet Weight (g) :	[redacted]
Wet Density (pcf) :	109.05	Wet Density (pcf) :	[redacted]
Moisture Content % :	41.50 EST	Moisture Content % :	[redacted]
Dry Density (pcf) :	77.07	Dry Density (pcf) :	[redacted]
Initial Void Ratio :	1.1780	Final Void Ratio :	[redacted]
Saturation ,% :	94.77	Saturation ,% :	[redacted]

Test Parameters

Fluid :	Site to GW-2	**Effective**	
Cell Pressure psi) :	65.00	**Confining Pressure (psi)** :	10
Head Water psi) :	56.70	Gradient :	24.69
Tail Water psi) :	53.30		

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	4.40
Length, L	(in)	:	3.80
Area, A	(sqin)	:	6.16
Head, h	**(psi)**	:	**3.40**
Time, t	(min)	:	1442.00
Temp, T	(Deg C)	:	18.8



Computed Permeability

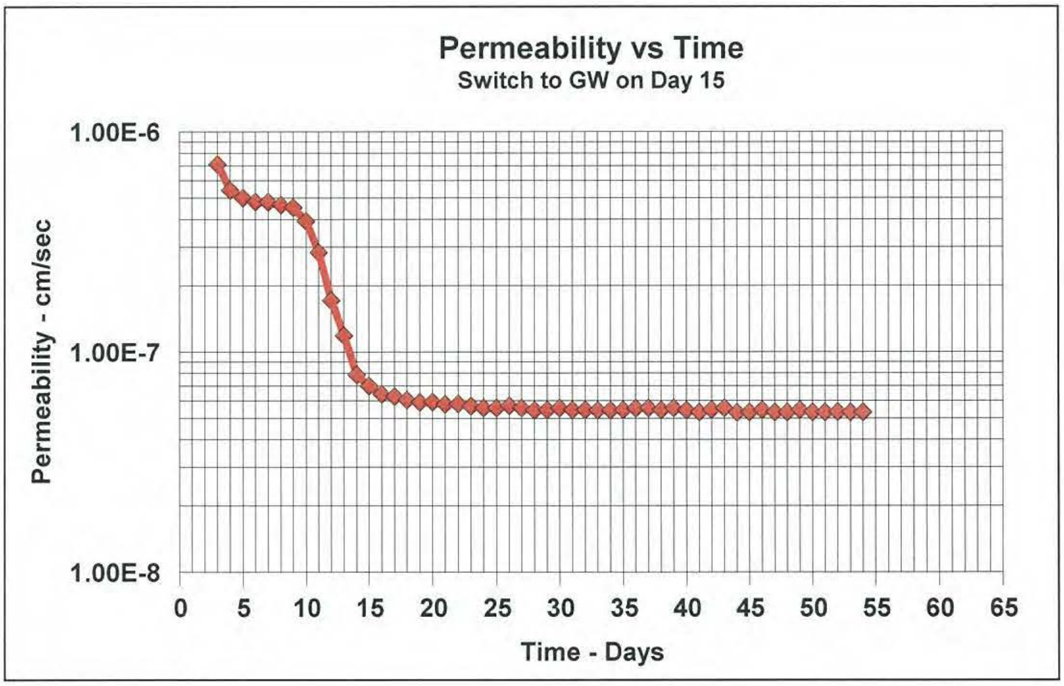
PERMEABILITY, K = 5.32E-008 **(cm/sec) at 20 Degrees C**

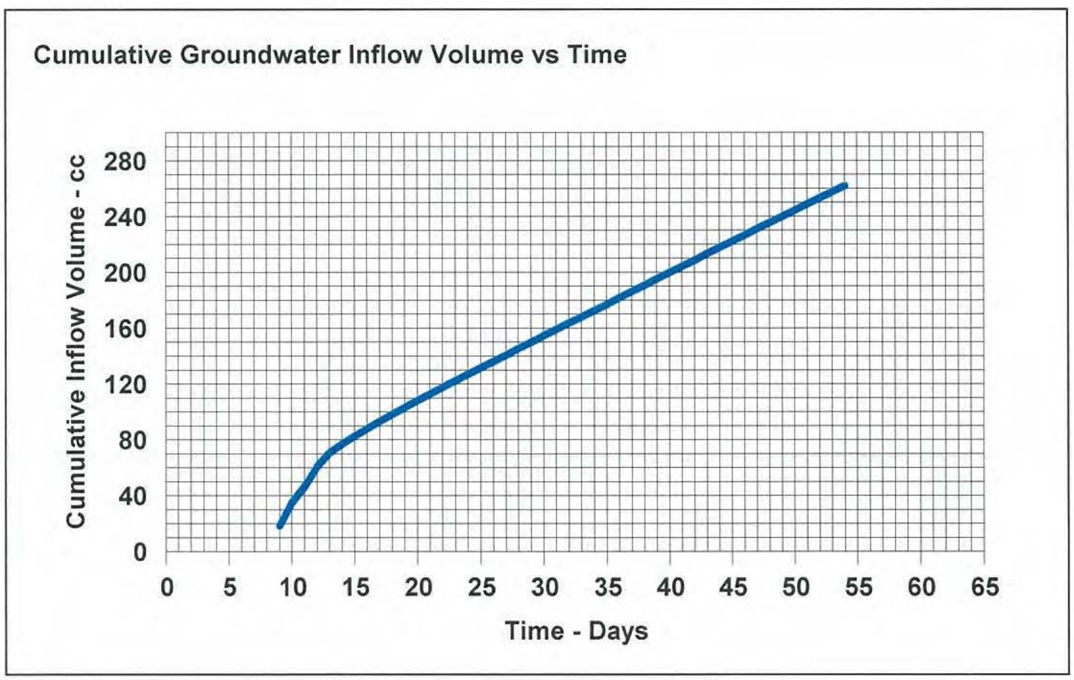
Day 54 **Total Groundwater Inflow to Date : 262.0 cc**

Description : Mix CB1-5 percent
Start Date : 07/27/2015

Permeant : Site to GW-2

Date : 09/18/2015
Estimated Initial Pore Volume 207.3 cc
Inflow Pore Volumes 1.26
Computed Final Pore Volume :





JLT Laboratories, Inc.

Client :	ERM	Date :	09/18/2015
oject Location :	Southern Premiere Edible Oils	Job No. :	15LS3238.02
Description :	Mix CB1-5 percent	Tested By :	MLB
Start Date :	07/27/2015	hecked By :	JBJr
Pore Volume :	207.3 cc		
l Pore Volume :	cc		Page 1

Elapsed Time Days	Permeability cm/sec	Inflow cc	Time minutes	Date	Total Cumulative Inflow, cc	Inflow Pore Volume	COMMENTS
1				07/27/2015		0	Start with Site Mix Water
2				07/28/2015		0.00	Consolidation of Sample
3	7.12E-007	14.7	360	07/29/2015		0.00	
4	5.42E-007	22.4	720	07/30/2015		0.00	
5	5.01E-007	20.7	720	07/31/2015		0.00	Inflow = Outflow
6	4.82E-007	19.9	720	08/01/2015		0.00	
7	4.79E-007	19.8	720	08/02/2015		0.00	
8	4.65E-007	19.2	720	08/03/2015		0.00	Switch to GW-2
9	4.53E-007	18.7	720	08/04/2015	18.7	0.09	
10	3.92E-007	16.2	720	08/05/2015	34.9	0.17	
11	2.83E-007	11.7	720	08/06/2015	46.6	0.22	
12	1.72E-007	14.2	1442	08/07/2015	60.8	0.29	
13	1.19E-007	9.8	1440	08/08/2015	70.6	0.34	
14	7.88E-008	6.5	1438	08/09/2015	77.1	0.37	
15	7.01E-008	5.8	1442	08/10/2015	82.9	0.40	
16	6.42E-008	5.3	1439	08/11/2015	88.2	0.43	
17	6.28E-008	5.2	1443	08/12/2015	93.4	0.45	
18	6.04E-008	5.0	1442	08/13/2015	98.4	0.47	
19	5.92E-008	4.9	1443	08/14/2015	103.3	0.50	
20	5.94E-008	4.9	1439	08/15/2015	108.2	0.52	
21	5.80E-008	4.8	1442	08/16/2015	113.0	0.55	
22	5.81E-008	4.8	1439	08/17/2015	117.8	0.57	
23	5.68E-008	4.7	1443	08/18/2015	122.5	0.59	
24	5.57E-008	4.6	1440	08/19/2015	127.1	0.61	
25	5.56E-008	4.6	1441	08/20/2015	131.7	0.64	
26	5.69E-008	4.7	1439	08/21/2015	136.4	0.66	
27	5.56E-008	4.6	1442	08/22/2015	141.0	0.68	
28	5.44E-008	4.5	1443	08/23/2015	145.5	0.70	
29	5.45E-008	4.5	1440	08/24/2015	150.0	0.72	
30	5.56E-008	4.6	1441	08/25/2015	154.6	0.75	30 Day Update
31	5.45E-008	4.5	1439	08/26/2015	159.1	0.77	
32	5.46E-008	4.5	1437	08/27/2015	163.6	0.79	
33	5.44E-008	4.5	1443	08/28/2015	168.1	0.81	
34	5.44E-008	4.5	1442	08/29/2015	172.6	0.83	
35	5.45E-008	4.5	1440	08/30/2015	177.1	0.85	
36	5.55E-008	4.6	1444	08/31/2015	181.7	0.88	
37	5.56E-008	4.6	1442	09/01/2015	186.3	0.90	
38	5.45E-008	4.5	1440	09/02/2015	190.8	0.92	
39	5.56E-008	4.6	1441	09/03/2015	195.4	0.94	
40	5.44E-008	4.5	1442	09/04/2015	199.9	0.96	
41	5.33E-008	4.4	1439	09/05/2015	204.3	0.99	
42	5.47E-008	4.5	1435	09/06/2015	208.8	1.01	
43	5.57E-008	4.6	1439	09/07/2015	213.4	1.03	
44	5.31E-008	4.4	1444	09/08/2015	217.8	1.05	
45	5.33E-008	4.4	1438	09/09/2015	222.2	1.07	
46	5.45E-008	4.5	1439	09/10/2015	226.7	1.09	
47	5.33E-008	4.4	1440	09/11/2015	231.1	1.11	
48	5.32E-008	4.4	1441	09/12/2015	235.5	1.14	
49	5.45E-008	4.5	1440	09/13/2015	240.0	1.16	
50	5.32E-008	4.4	1442	09/14/2015	244.4	1.18	
51	5.32E-008	4.4	1441	09/15/2015	248.8	1.20	
52	5.34E-008	4.4	1437	09/16/2015	253.2	1.22	Page 2
53	5.32E-008	4.4	1442	09/17/2015	257.6	1.24	
54	5.32E-008	4.4	1442	09/18/2015	262.0	1.26	

SUMMARY OF FLEX WALL COMPATIBILITY
TEST RESULTS
ASTM D-7100 and EPA 9100 Compatibility Testing

JLT

Client :	ERM	Print Date :	09//2015
Project Location :	Southern Premiere Edible Oils	Job No. :	15LS3238.02
Description :	Mix CB1-5 Bent and 3 Organo Clay	Tested By :	MLB
Start Date :	07/28/2015	Checked By :	JBJr
Mix Moisture Content	53.05 %	Panel No :	24
Fines Content :	31.1 %	Spec. Gravity :	2.70 Assumed

Physical Property Data

Initial Height (in) :	3.92	Final Height (in) :	[redacted]
Initial Diameter (in) :	2.80	Final Diameter (in) :	
Initial Wet Weight (g) :	690.10	Final Wet Weight (g) :	
Wet Density (pcf) :	108.82	Wet Density (pcf) :	
Moisture Content % :	46.80 EST	Moisture Content % :	
Dry Density (pcf) :	74.13	Dry Density (pcf) :	
Initial Void Ratio :	1.2728	Final Void Ratio :	
Saturation ,% :	99.28	Saturation ,% :	

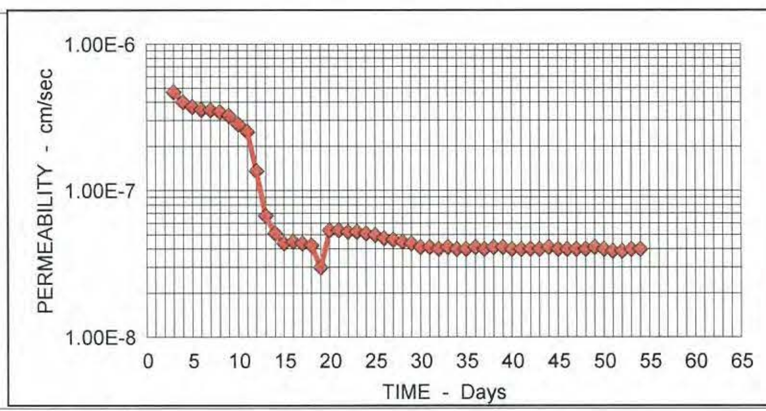
Test Parameters

Fluid :	Site to GW-2	**Effective**	
Cell Pressure psi) :	65.00	**Confining Pressure (psi)** :	10
Head Water psi) :	56.70	Gradient :	23.94
Tail Water psi) :	53.30		

Permeability Input Data

For Last Data Point

Flow, Q	(cc) :	3.20
Length, L	(in) :	3.92
Area, A	(sqin) :	6.16
Head, h	**(psi)** :	**3.40**
Time, t	(min) :	1442.00
Temp, T	(Deg C) :	18.8



Computed Permeability

PERMEABILITY, K = 3.99E-008 **(cm/sec) at 20 Degrees C**

Day 54 **Total Groundwater Inflow to Date : 191.6 cc**

Description : Mix CB1-5 Bent and 3 Organo Clay

Start Date : 07/28/2015

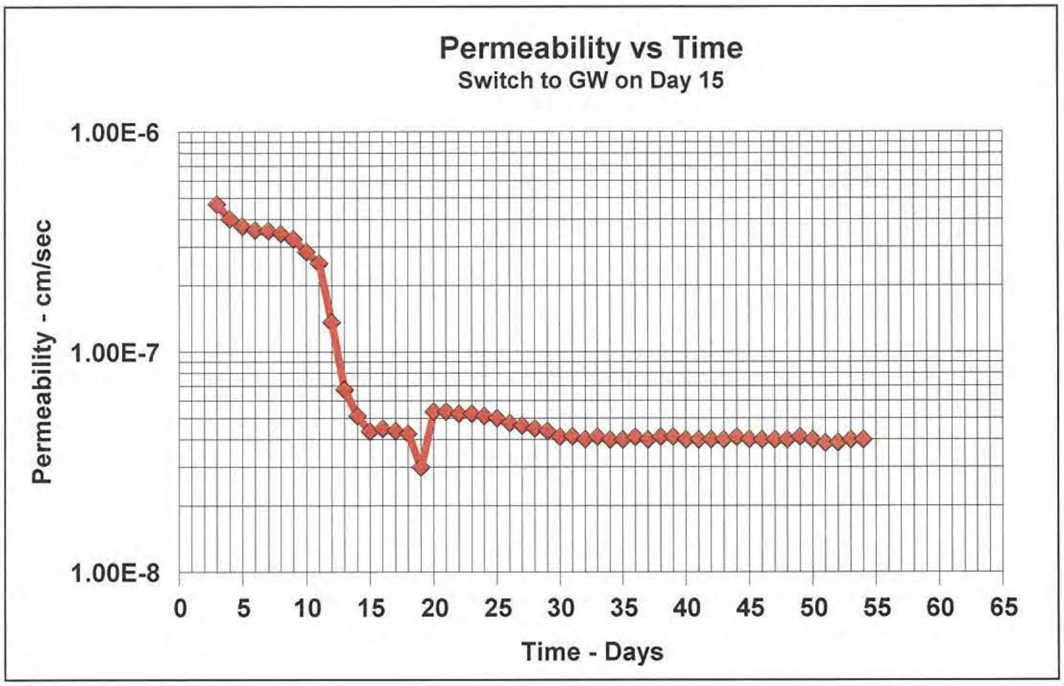
Permeant : Site to GW-2

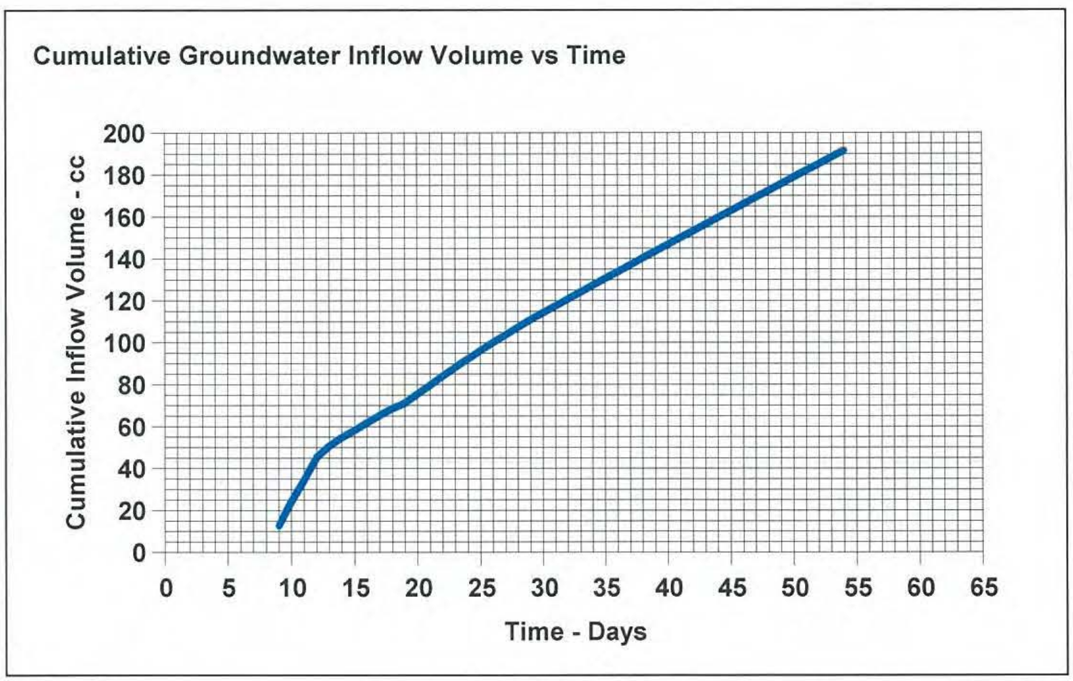
Date : 09//2015

'Estimated Pore Volume 228.6 cc

Inflow Pore Volumes 0.84

Computed Final Pore Volume :





JLT Laboratories, Inc.

Client : ERM
Project Location : Southern Premiere Edible Oils
Description : Mix CB1-5 Bent and 3 Organo Clay
Start Date : 07/28/2015
Pore Volume : 228.6 cc
Final Pore Volume : cc

Date : 09//2015
Job No. : 15LS3238.02
Tested By : MLB
Checked By : JBJr

Page 1

Elapsed Time Days	Permeability cm/sec	Inflow cc	Time minutes	Date	Total Cumulative Inflow, cc	Inflow Pore Volume	COMMENTS
1				07/27/2015		0	Start with Site Mix Water
2				07/28/2015		0.00	Consolidation of Sample
3	4.70E-007	18.8	720	07/29/2015		0.00	
4	4.02E-007	16.1	720	07/30/2015		0.00	
5	3.72E-007	14.9	720	07/31/2015		0.00	
6	3.57E-007	14.3	720	08/01/2015		0.00	Inflow = Outflow
7	3.55E-007	14.2	720	08/02/2015		0.00	
8	3.45E-007	13.8	720	08/03/2015		0.00	Switch to GW-2
9	3.25E-007	13.0	720	08/04/2015	13.0	0.06	
10	2.85E-007	11.4	720	08/05/2015	24.4	0.11	
11	2.52E-007	10.1	720	08/06/2015	34.5	0.15	
12	1.36E-007	10.9	1440	08/07/2015	45.4	0.20	
13	6.73E-008	5.4	1442	08/08/2015	50.8	0.22	
14	5.12E-008	4.1	1439	08/09/2015	54.9	0.24	
15	4.36E-008	3.5	1442	08/10/2015	58.4	0.26	
16	4.49E-008	3.6	1443	08/11/2015	62.0	0.27	
17	4.37E-008	3.5	1439	08/12/2015	65.5	0.29	
18	4.25E-008	3.4	1438	08/13/2015	68.9	0.30	
19	2.99E-008	2.4	1442	08/14/2015	71.3	0.31	Backwash Inflow
20	5.37E-008	4.3	1441	08/15/2015	75.6	0.33	
21	5.37E-008	4.3	1441	08/16/2015	79.9	0.35	
22	5.24E-008	4.2	1440	08/17/2015	84.1	0.37	
23	5.24E-008	4.2	1441	08/18/2015	88.3	0.39	
24	5.11E-008	4.1	1442	08/19/2015	92.4	0.40	
25	4.99E-008	4.0	1441	08/20/2015	96.4	0.42	
26	4.75E-008	3.8	1439	08/21/2015	100.2	0.44	
27	4.63E-008	3.7	1438	08/22/2015	103.9	0.45	
28	4.49E-008	3.6	1443	08/23/2015	107.5	0.47	
29	4.37E-008	3.5	1440	08/24/2015	111.0	0.49	
30	4.12E-008	3.3	1442	08/25/2015	114.3	0.50	30 DayUpdate
31	4.12E-008	3.3	1439	08/26/2015	117.6	0.51	
32	4.00E-008	3.2	1437	08/27/2015	120.8	0.53	
33	4.11E-008	3.3	1443	08/28/2015	124.1	0.54	
34	3.99E-008	3.2	1442	08/29/2015	127.3	0.56	
35	4.00E-008	3.2	1440	08/30/2015	130.5	0.57	
36	4.11E-008	3.3	1444	08/31/2015	133.8	0.59	
37	3.99E-008	3.2	1442	09/01/2015	137.0	0.60	
38	4.12E-008	3.3	1440	09/02/2015	140.3	0.61	
39	4.12E-008	3.3	1441	09/03/2015	143.6	0.63	
40	3.99E-008	3.2	1442	09/04/2015	146.8	0.64	
41	4.00E-008	3.2	1439	09/05/2015	150.0	0.66	
42	4.01E-008	3.2	1435	09/06/2015	153.2	0.67	
43	4.00E-008	3.2	1439	09/07/2015	156.4	0.68	
44	4.11E-008	3.3	1444	09/08/2015	159.7	0.70	
45	4.00E-008	3.2	1438	09/09/2015	162.9	0.71	
46	4.00E-008	3.2	1439	09/10/2015	166.1	0.73	
47	4.00E-008	3.2	1440	09/11/2015	169.3	0.74	
48	3.99E-008	3.2	1441	09/12/2015	172.5	0.75	
49	4.12E-008	3.3	1440	09/13/2015	175.8	0.77	
50	3.99E-008	3.2	1442	09/14/2015	179.0	0.78	
51	3.87E-008	3.1	1441	09/15/2015	182.1	0.80	
52	3.88E-008	3.1	1437	09/16/2015	185.2	0.81	Page 2
53	3.99E-008	3.2	1442	09/17/2015	188.4	0.82	
54	3.99E-008	3.2	1442	09/18/2015	191.6	0.84	

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

July 30, 2015
15LS3238.01

ERM, Inc.
1001 SW 5th Ave
Suite 1010
Portland, OR 97204

Attn: Kathryn Ewing

RE: SOIL BENTONITE BARRIER WALL
SOUTHERN PREMIERE EDIBLE OILS SITE
PORTLAND, OREGON
PROJECT NO: 0283866

Dear Ms. Ewing:

Submitted herein are the results of our trial soil-bentonite mixes and our recommendations for the design mix. This work included 3 phases as described below:

Phase I - Geotechnical & Water Testing

This phase evaluated the two provided soil types identified as CB-1 and CB-2. We also evaluated the mix water and the two groundwater samples.

Geotechnical Testing Included:

1.) As-Received Moisture Content

2.) Sieve Analysis

3.) Atterberg Limits

4.) pH

5.) Specific Gravity

Both samples were predominately medium to fine sand with about 6% fines in CB-1 and about 23% fines in CB-2. The pH was slightly less than 7 with no significant organics. The specific gravity of 2.67 is typical for this material type. Results of these tests are included in Attachment 1.

938 South Central Avenue • Canonsburg, Pennsylvania 15317 • Tel: (724) 746-4441 • Fax: (724) 745-4261
www.jltlabs.com

Basic testing on the water samples were as follows:

	Site Mix Water	GW-1	GW-2
pH	7.2	6.5	6.3
TDS, ppt	0.03	0.11	0.17
Alkalinity, ppm	80	180	180
Hardness, ppm	50	250	250

The sand with few non-plastic fines will require sufficient bentonite to swell so as to fill the voids. The site water exhibits no evidence to indicate it will adversely effect bentonite performance. The two groundwater samples did exhibit moderate hardness (calcium and magnesium content). This can effect the performance of sodium bentonite. Phase II testing evaluates this concern.

Phase II - Bentonite Evaluation

To evaluate the performance of bentonite a series of two tests were performed.

Swell Index: This test evaluates the swell potential of bentonite with site mix water and when the mix water is contaminated with 15% site groundwater.

Fluid Loss: This test evaluates the ability of bentonite slurry to develop a filter cake in the trench walls and the ability to retard flow through the filter cake so as to maintain trench stability. The test was performed with site mix water and with site mix water contaminated with groundwater.

We evaluated 3 bentonite types currently available for barrier walls.

Premium Gel 90
WyoBen 90
Western Bentonite 90

All 3 bentonites meet API Section 9 criteria. Based on our water tests we used GW-2 as the groundwater for these tests.

As shown on Attachment 2, Swell Index tests were performed using 100% site mix water and again with site mix water that was contaminated with 15% GW-2 groundwater.

The manufacturer's warranted value using distilled water is, at least, 24 ml of swell. By inspection and the photos it is clear that Western Bentonite 90 out performed the other 2 bentonites. It is also noted the source of Western Bentonite is closest to your site which will reduce transportation costs.

Fluid Loss was also performed with 100% site mix water and mix water contaminated with 15% GW-2 groundwater. Using distilled water the warranted value is equal to or less than 18 ml of fluid loss and a filter cake thickness of about 1/16th to 3/32 of an inch.

The results of the tests are as follows:

100% Site Mix Water			
	Premium Gel 90	WyoBen 90	Western Bentonite 90
Fluid Loss, ml	15	15	16
Filter Cake, in	3/32	4/32	4/32
Site Mix Water with 15% GW-2 Groundwater			
	Premium Gel 90	WyoBen 90	Western Bentonite 90
Fluid Loss, ml	17	18	16
Filter Cake, in	4/32	3/32	4/32

These test results indicate the slurry should perform well in the trench with no significant adverse effect on performance.

However, as seen on the Swell Index photo, the groundwater contaminated tests developed a yellow-orange accumulation on the top of the test cylinders. The fact that is has a density less than water and a yellow-orange color suggests a hydrocarbon based product. The odor also suggests hydrocarbons.

Phase III - Trial Mixes

Based on the results of Phase II testing we selected Western 90 bbl bentonite. It performed the best and the source is closest to your site.

Trail mixes included the following:

1.) Preparation of a 40 second slurry using site mix water and bentonite. A total of 8 liters of site mix water was prepared. To achieve a 40 second slurry the bentonite content was 46.5 gr of bentonite per liter of water after 24 hours of hydration.

2.) Preparations of 7 trial mixes for each of the two soil types were as follows:

TM1-CB1	3% Dry Bentonite by Moist Soil Weight 375 cc of 40 sec Slurry to Achieve a 5+ in Slump
TM2-CB1	4% Dry Bentonite by Moist Soil Weight 410 cc of 40 sec Slurry to Achieve a 5+ in Slump
TM3-CB1	5% Dry Bentonite by Moist Soil Weight 450 cc of 40 sec Slurry to Achieve a 5+ in Slump
TM1-CB2	3% Dry Bentonite by Moist Soil Weight 385 cc of 40 sec Slurry to Achieve a 5+ in Slump
TM2-CB2	4% Dry Bentonite by Moist Soil Weight 415 cc of 40 sec Slurry to Achieve a 5+ in Slump
TM3-CB2	5% Dry Bentonite by Moist Soil Weight 455 cc of 40 sec Slurry to Achieve a 5+ in Slump
TM4-CB2	6% Dry Bentonite by Moist Soil Weight 480 cc of 40 sec Slurry to Achieve a 5+ in Slump

Each mix was tested for permeability per ASTM D-5084 - Method A using an Effective Stress of 10 psi and Gradient of about 25. The results of these tests are included in Attachment III - Trial Mixes. We also plotted Permeability vs Dry Bentonite content. We understand the project specifications require a field permeability of no greater than $1x10^{-7}$ cm/sec. To account for slight changes in soil properties the laboratory taregt permeability is $5x10^{-8}$ cm/sec to provide a reasonable Factor of Safety.

Based on these test results, at least 5% dry bentonite is required to achieve a laboratory value of about $5x10^{-8}$ cm/sec as seen in Attachment III. Since CB-1 contains the least amount of fines it is recommended the design mix contain 5% dry bentonite plus 450 ml of 40 sec slurry. Since the 40 sec slurry contains 46.5 gr/liter, the bentonite contribution via slurry to the mix is 20.9 grams of bentonite. This high bentonite content is not unusual considering CB-1 soil contains few fines and the fines are non-plastic.

<u>Phase IV - Design Mix Compatibility Testing</u>

We prepared the design mix as described above and initiated the compatibility tests. Once we confirm the design permeability of about $5x10^{-8}$ cm/sec, the permeant will be switched to groundwater. We plan to use GW-2 unless otherwise requested.

During the preparation of the trial mixes we noted the odor of hydrocarbons. This order correlated well with the observations of hydrocarbons in the Swell Index tests.

Therefore, we also prepared the same design mix with the addition of 3% CETCO Organo clay. Organo clay only hydrates in the presence of hydrocarbons.

With the addition of 3% Organo clay by weight of soil, the amount of 40 sec slurry required to achieve the same slump increased from 450 cc of slurry to almost 600 ml of slurry. This added slurry suggests the Organo clay swelled absorbing hydrocarbons. Both tests are currently in progress using water as the permeant. Additional testing suggestions will be submitted in a separate letter.

We appreciate the opportunity to provide our services and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

JLT LABORATORIES, INC.

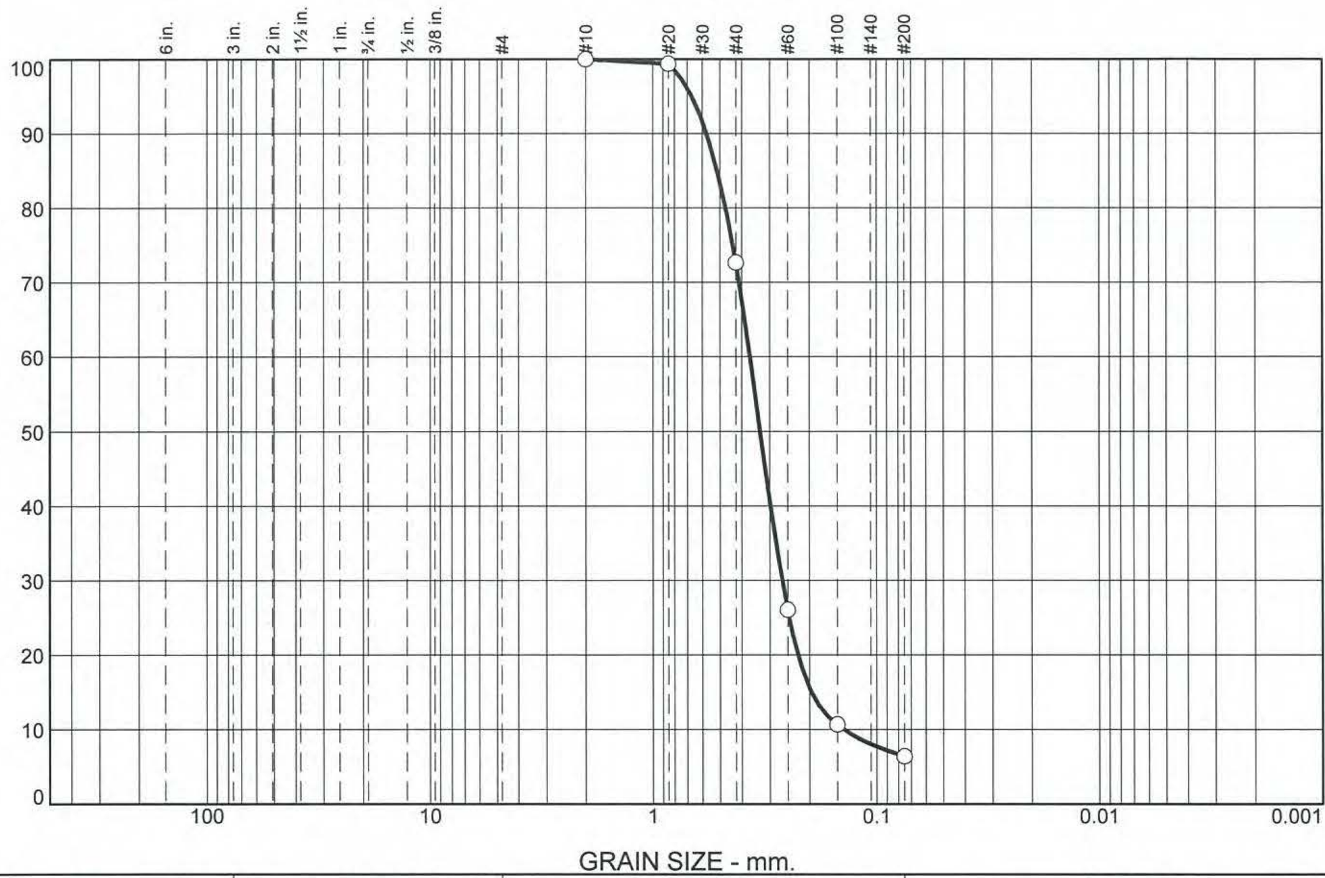
John Boschuk, Jr., P.E., C.F.E.
President

Enclosures
JB/mlb
\wp10\letter\15200
Inv# 6048

ATTACHMENT 1

Phase I - Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	27.3	66.3	6.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.4		
#40	72.7		
#60	26.1		
#100	10.7		
#200	6.4		

* (no specification provided)

Material Description

Boring Composite
5 Gallon Bucket

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.5726 D_{85}= 0.5137 D_{60}= 0.3675
D_{50}= 0.3310 D_{30}= 0.2642 D_{15}= 0.1951
D_{10}= 0.1397 C_u= 2.63 C_c= 1.36

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 10.8%
pH = 6.8 / Specific Gravity = 2.67

Location: Portland, OR
Sample Number: CB-1 **Depth:** 0-30' **Date:** 06/23/2015

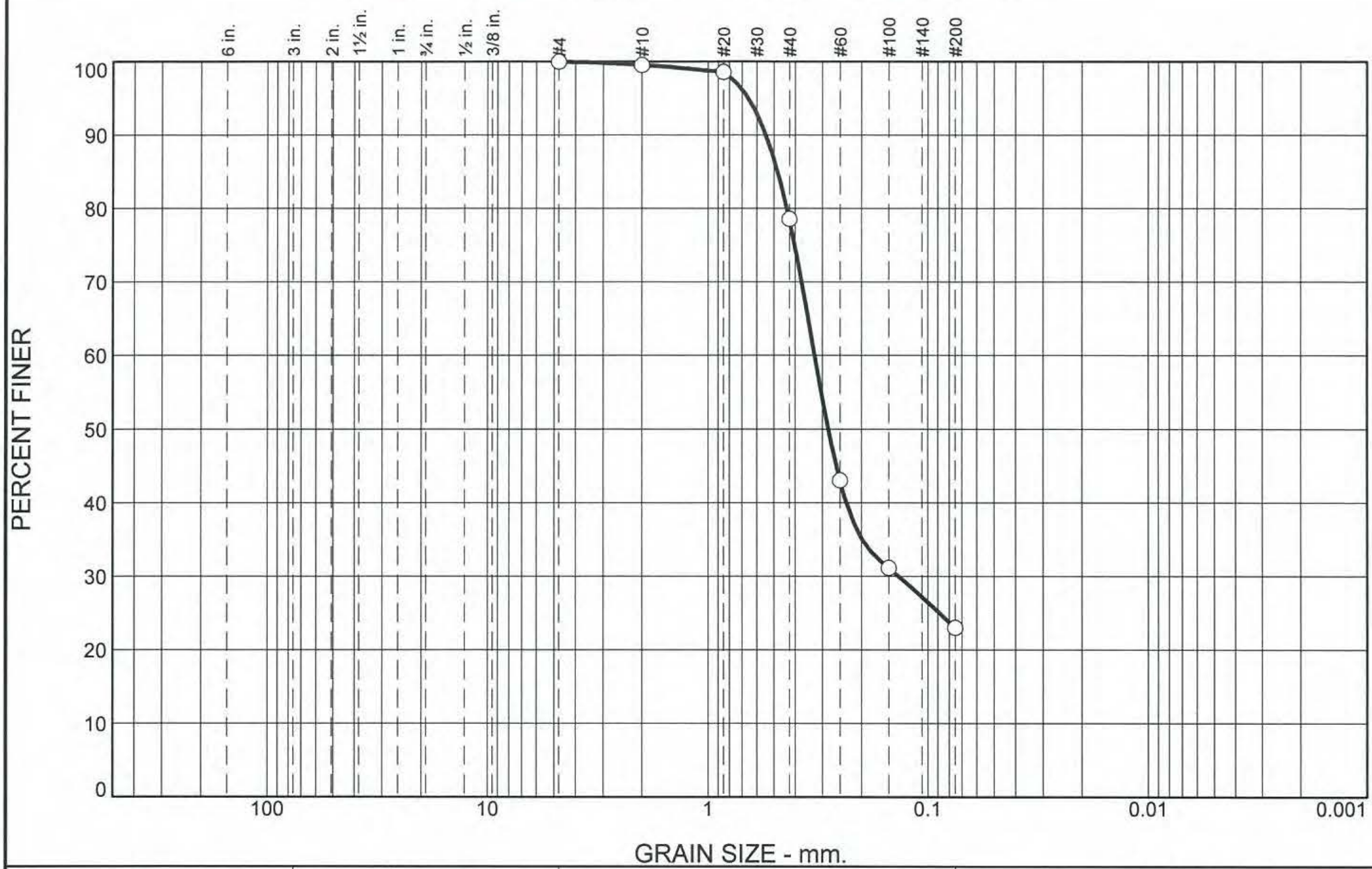
JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: Groundwater Barrier Wall - Southern PEO Site
ERM Project No: 0283866
Project No: 15LS3238.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	20.9	55.6	23.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.5		
#20	98.6		
#40	78.6		
#60	43.0		
#100	31.1		
#200	23.0		

* (no specification provided)

Material Description

Boring Composite
5 Gallon Bucket

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.5436 D_{85}= 0.4798 D_{60}= 0.3253
D_{50}= 0.2819 D_{30}= 0.1352 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 17.1%
pH = 5.6 / Specific Gravity = 2.67

Location: Portland, OR
Sample Number: CB-2 **Depth:** 0-30' **Date:** 06/23/2015

JLT Laboratories, Inc.

Canonsburg, PA

Client: ERM
Project: Groundwater Barrier Wall - Southern PEO Site
ERM Project No: 0283866
Project No: 15LS3238.01 **Figure**

Tested By: RL **Checked By:** JB

JLT Laboratories, Inc.
Geotechnical, Geosynthetic and Materials Testing and Research

938 South Central Avenue
Canonsburg, Pennsylvania, 15317
Tel: 724-746-4441 Fax: 724-745-4261
e-mail: jboschuk@jltlabs.com
www.jltlabs.com

Client:	ERM	**Date:**	06/25/2015
		JLT Project No:	15LS3238.01
Project:	Groundwater Barrier Wall Southern PEO Site ERM Project No: 0283866		

Water Tests

Site Mix Water	
pH	7.2
TDS	0.03 ppt
Hardness	50 ppm
Alkalinity	80 ppm

Groundwater	
pH	6.5
TDS	0.11 ppt
Hardness	250 ppm
Alkalinity	180 ppm

Enclosures
JB/mlb
\wp10\misc\1512

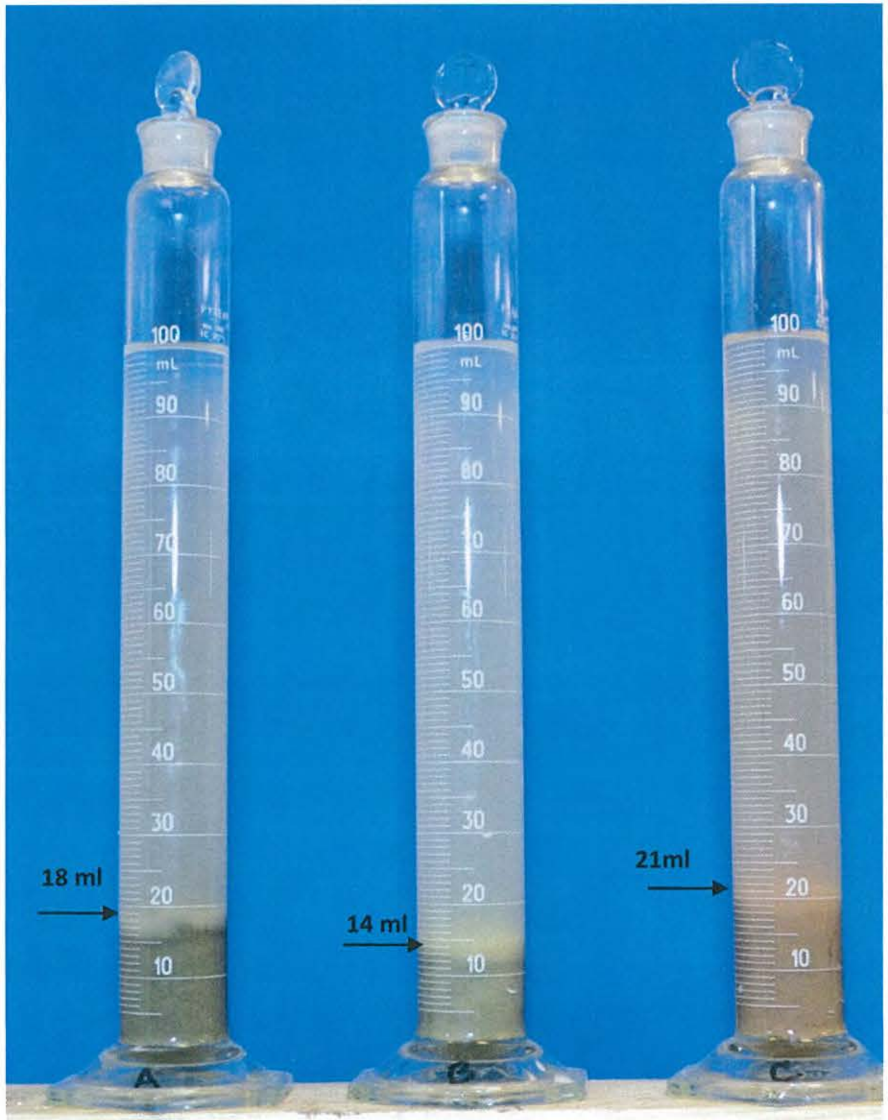
ATTACHMENT 2

Bentonite Evaluations

SWELL INDEX TEST RESULTS

Warranted Value in Distilled Water >/= 24 ml

Premium Gel 90 **WyoBen 90** **Western Bentonite 90**



100% Site Mix Water

Premium Gel 90 **WyoBen 90** **Western Bentonite 90**

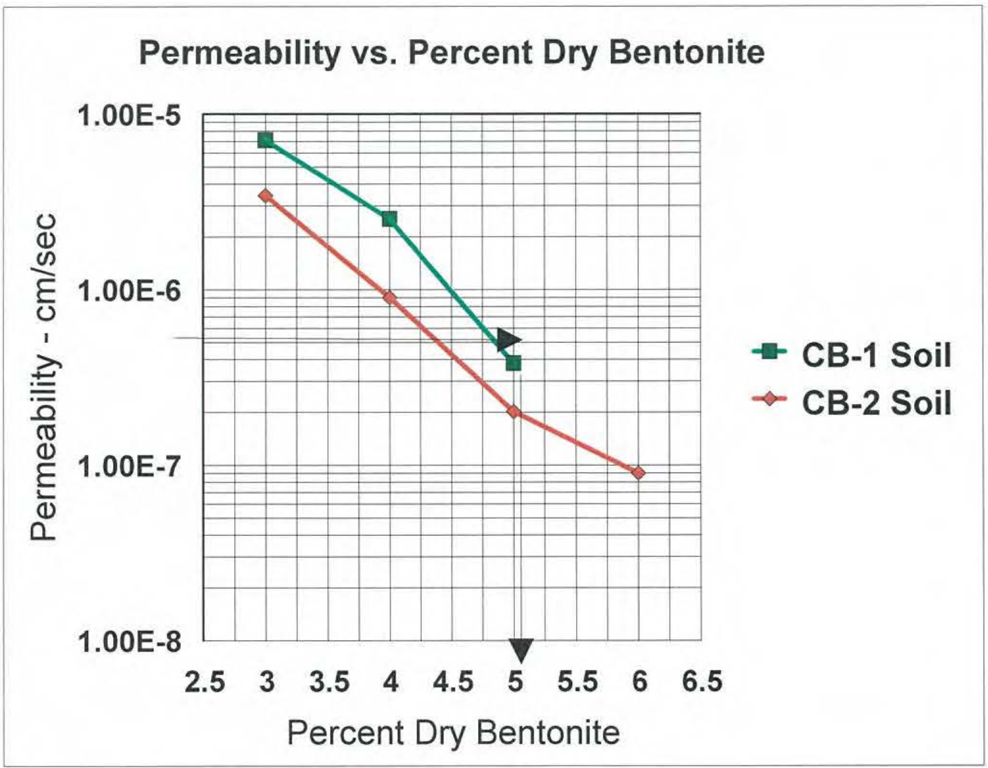
Site Water Contaminated with 15% Groundwater

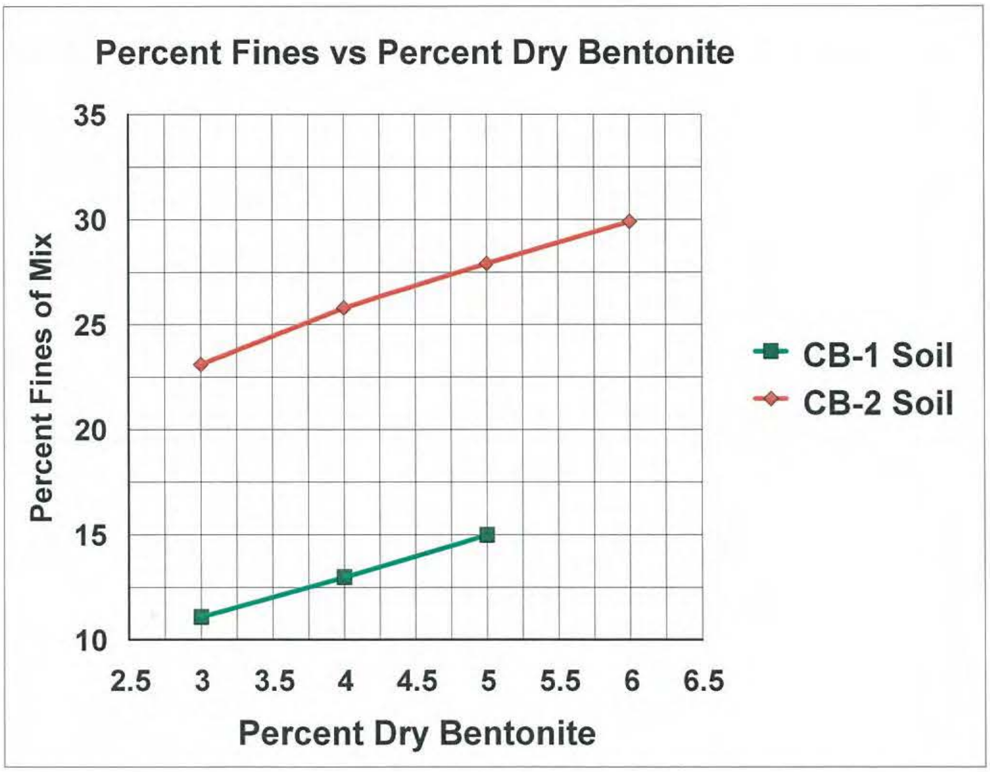
JLT Laboratories, Inc.

ATTACHMENT 3

Trial Mixes

Bentonite : Western Section 9 Bentonite





Design Mix : 5% Dry Bentonite by weight of moist soil plus
40 sec Bentonite slurry for 5 to 6 inch slump

SUMMARY OF FLEX WALL PERMEABILITY TEST RESULTS

ASTM D-5084 (Method A)

JLT

Client :	ERM	Print Date :	07/18/2015
Project Location :	Southern Premiere Edible Oils	Job No. :	15LS3238.01
Sample Number :	Mix CB-1 3% Dry	Tested By :	TM / MLB
:		Checked By :	JBJr
As-Prepared M/C :	37.55%	Page 1 of 2	Page 2 Optional
Percent Fines :	11.1%	Spec. Gravity :	2.66 Assumed
:		ERM Job No. :	0283866

Physical Property Data

Initial Height (in) :	4.58	Final Height (in) :	4.27
Initial Diameter (in) :	2.79	Final Diameter (in) :	2.75
Initial Wet Weight (g) :	811.10	Final Wet Weight (g) :	794.01
Wet Density (pcf) :	110.26	Wet Density (pcf) :	119.16
Moisture Content % :	33.70	Moisture Content % :	30.88
Dry Density (pcf) :	82.47	Dry Density (pcf) :	91.04
Initial Void Ratio :	1.0128	Final Void Ratio :	0.8231
Saturation ,% :	88.5	Saturation ,% :	99.8

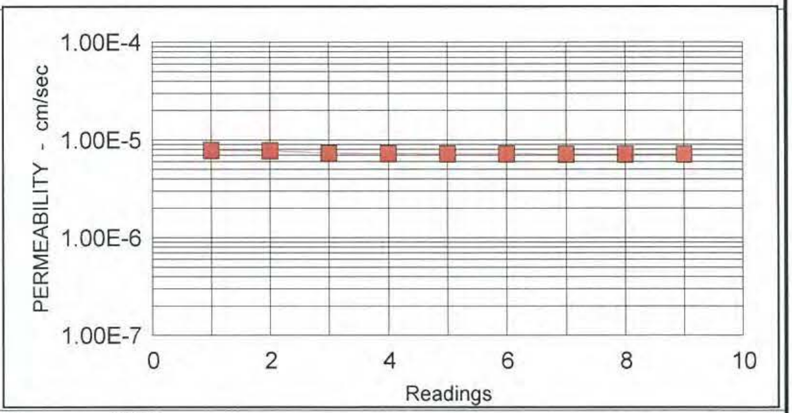
Test Parameters

Fluid :	De-Aired Water	**Effective**	
Cell Pressure psi) :	65.00	**Confining Pressure (psi) :**	**10**
Head Water ›si) :	56.80	Gradient :	23.27
Tail Water ›si) :	53.20		

Permeability Input Data

For Last Data Point

Flow, Q	(cc)	:	22.30
Length, L	(in)	:	4.27
Area, A	(sqin)	:	5.94
Head, h	**(psi)**	**:**	**3.60**
Time, t	(min)	:	60.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K = 7.16E-006 **(cm/sec) at 20 Degrees C**

Average of Last 3 Readings 7.16E-006 **cm/sec**

SUMMARY OF FLEX WALL PERMEABILITY
TEST RESULTS
ASTM D-5084 (Method A)

Client	:	ERM	Print Date	:	07/18/2015
Project Location	:	Southern Premiere Edible Oils	Job No.	:	!%LS3238.01
Sample Number	:	Mix CB-1 4% Dry	Tested By	:	TM / MLB
	:		Checked By	:	JBJr
As-Prepared M/C	:	38.09%	Page 1 of 2		Page 2 Optional
Percent Fines	:	13.0%	Spec. Gravity	:	2.66 Assumed
	:		ERM Job No.	:	0283866

Physical Property Data

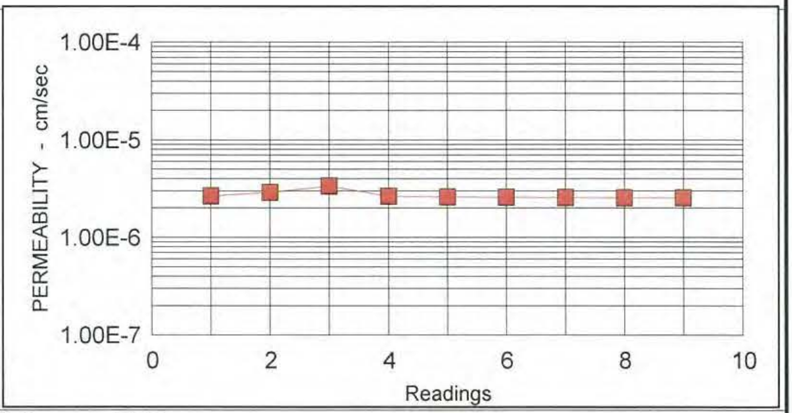
Initial Height (in)	:	4.05	Final Height (in)	:	3.93
Initial Diameter (in)	:	2.79	Final Diameter (in)	:	2.74
Initial Wet Weight (g)	:	734.00	Final Wet Weight (g)	:	720.60
Wet Density (pcf)	:	112.83	Wet Density (pcf)	:	118.36
Moisture Content %	:	34.45	Moisture Content %	:	32.00
Dry Density (pcf)	:	83.92	Dry Density (pcf)	:	89.67
Initial Void Ratio	:	0.9779	Final Void Ratio	:	0.8511
Saturation ,%	:	93.7	Saturation ,%	:	100.0

Test Parameters

Fluid	:	De-Aired Water	**Effective**		
Cell Pressure psi)	:	65.00	**Confining Pressure (psi)**	:	**10**
Head Water ɔsi)	:	56.80	Gradient	:	25.28
Tail Water ɔsi)	:	53.20			

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	14.30
Length, L	(in)	:	3.93
Area, A	(sqin)	:	5.90
Head, h	**(psi)**	:	**3.60**
Time, t	(min)	:	100.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K = 2.55E-006 **(cm/sec) at 20 Degrees C**
Average of Last 3 Readings 2.56E-006 **cm/sec**

SUMMARY OF FLEX WALL PERMEABILITY
TEST RESULTS
ASTM D-5084 (Method A)

Client	:	ERM	Print Date	:	07/18/2015
Project Location	:	Southern Premiere Edible Oils	Job No.	:	15LS3238.01
Sample Number	:	Mix CB-1 5% Dry	Tested By	:	TM / MLB
	:		Checked By	:	JBJr
As-Prepared M/C	:	44.20%	Page 1 of 2		Page 2 Optional
Percent Fines	:	15.0%	Spec. Gravity	:	2.66 Assumed
	:		ERM Job No.	:	0283866

Physical Property Data

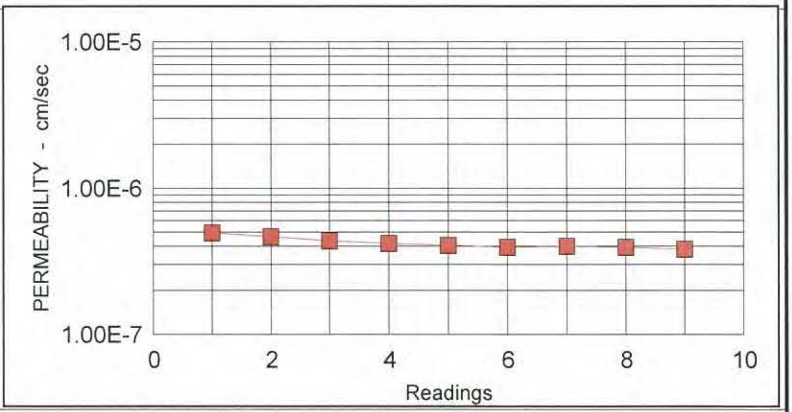
Initial Height (in)	:	3.98	Final Height (in)	:	3.90
Initial Diameter (in)	:	2.78	Final Diameter (in)	:	2.74
Initial Wet Weight (g)	:	719.60	Final Wet Weight (g)	:	714.30
Wet Density (pcf)	:	113.38	Wet Density (pcf)	:	118.23
Moisture Content %	:	33.14	Moisture Content %	:	32.16
Dry Density (pcf)	:	85.16	Dry Density (pcf)	:	89.46
Initial Void Ratio	:	0.9492	Final Void Ratio	:	0.8554
Saturation ,%	:	92.9	Saturation ,%	:	100.0

Test Parameters

Fluid	:	De-Aired Water	**Effective**		
Cell Pressure psi)	:	65.00	**Confining Pressure (psi)**	:	**10**
Head Water ɔsi)	:	56.80	Gradient	:	25.48
Tail Water ɔsi)	:	53.20			

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	6.70
Length, L	(in)	:	3.90
Area, A	(sqin)	:	5.90
Head, h	**(psi)**	:	**3.60**
Time, t	(min)	:	310.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K =	3.83E-007	**(cm/sec) at 20 Degrees C**
Average of Last 3 Readings	3.94E-007	**cm/sec**

SUMMARY OF FLEX WALL PERMEABILITY
TEST RESULTS
ASTM D-5084 (Method A)

JLT

Client	:	ERM	Print Date	:	07/18/2015
Project Location	:	Southern Premiere Edible Oils	Job No.	:	15LS3238.01
Sample Number	:	Mix CB-2 3% Dry	Tested By	:	TM / MLB
	:		Checked By	:	JBJr
As-Prepared M/C	:	39.65%	Page 1 of 2		Page 2 Optional
Percent Fines	:	23.1%	Spec. Gravity	:	2.66 Assumed
	:		ERM Job No.	:	0283866

Physical Property Data

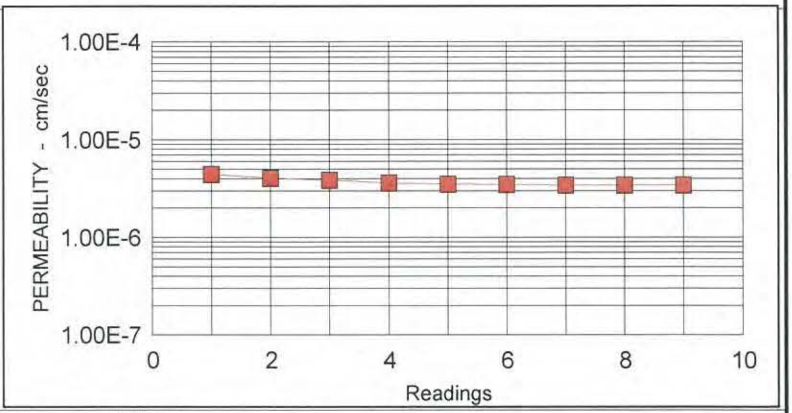
Initial Height (in)	:	4.25	Final Height (in)	:	4.18
Initial Diameter (in)	:	2.80	Final Diameter (in)	:	2.74
Initial Wet Weight (g)	:	797.00	Final Wet Weight (g)	:	771.69
Wet Density (pcf)	:	115.92	Wet Density (pcf)	:	119.17
Moisture Content %	:	35.23	Moisture Content %	:	30.94
Dry Density (pcf)	:	85.72	Dry Density (pcf)	:	91.01
Initial Void Ratio	:	0.9364	Final Void Ratio	:	0.8237
Saturation ,%	:	100.1	Saturation ,%	:	99.9

Test Parameters

Fluid	:	De-Aired Water	**Effective**		
Cell Pressure psi)	:	65.00	**Confining Pressure (psi)**	:	**10**
Head Water ɔsi)	:	56.80	Gradient	:	23.77
Tail Water ɔsi)	:	53.20			

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	16.30
Length, L	(in)	:	4.18
Area, A	(sqin)	:	5.90
Head, h	**(psi)**	:	**3.60**
Time, t	(min)	:	90.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K =	3.44E-006	**(cm/sec) at 20 Degrees C**
Average of Last 3 Readings	3.44E-006	**cm/sec**

SUMMARY OF FLEX WALL PERMEABILITY
TEST RESULTS
ASTM D-5084 (Method A)

JLT

Client	:	ERM	Print Date	:	07/18/2015
Project Location	:	Southern Premiere Edible Oils	Job No.	:	15LS3238.01
Sample Number	:	Mix CB-2 4% Dry	Tested By	:	TM / MLB
	:		Checked By	:	JBJr
As-Prepared M/C	:	39.89%	Page 1 of 2		Page 2 Optional
Percent Fines	:	25.8%	Spec. Gravity	:	2.66 Assumed
	:		ERM Job No.	:	0283866

Physical Property Data

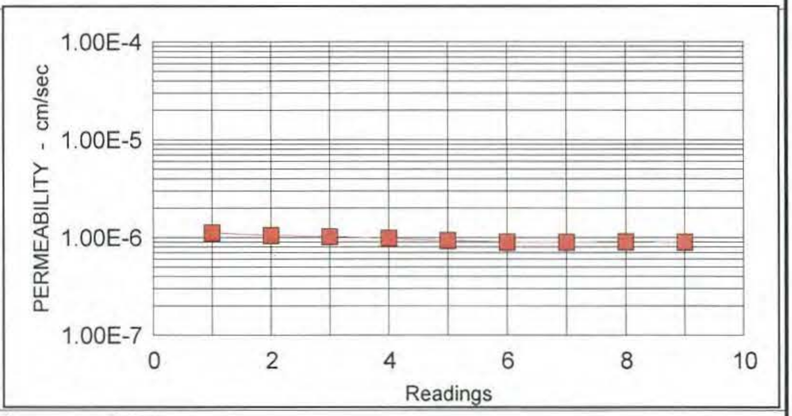
Initial Height (in)	:	4.38	Final Height (in)	:	4.29
Initial Diameter (in)	:	2.80	Final Diameter (in)	:	2.74
Initial Wet Weight (g)	:	821.20	Final Wet Weight (g)	:	790.68
Wet Density (pcf)	:	115.89	Wet Density (pcf)	:	118.97
Moisture Content %	:	36.24	Moisture Content %	:	31.18
Dry Density (pcf)	:	85.07	Dry Density (pcf)	:	90.70
Initial Void Ratio	:	0.9512	Final Void Ratio	:	0.8301
Saturation ,%	:	101.3	Saturation ,%	:	99.9

Test Parameters

Fluid	:	De-Aired Water	**Effective**		
Cell Pressure psi)	:	65.00	**Confining Pressure (psi)**	:	**10**
Head Water ɔsi)	:	56.80	Gradient	:	23.16
Tail Water ɔsi)	:	53.20			

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	11.10
Length, L	(in)	:	4.29
Area, A	(sqin)	:	5.90
Head, h	**(psi)**	:	**3.60**
Time, t	(min)	:	240.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K =	9.02E-007	**(cm/sec) at 20 Degrees C**
Average of Last 3 Readings	9.05E-007	**cm/sec**

SUMMARY OF FLEX WALL PERMEABILITY
TEST RESULTS
ASTM D-5084 (Method A)

JLT

Client	:	ERM	Print Date	:	07/18/2015
Project Location	:	Southern Premiere Edible Oils	Job No.	:	15LS3238.01
Sample Number	:	Mix CB-2 5% Dry	Tested By	:	TM /MLB
	:		Checked By	:	JBJr
As-Prepared M/C	:	47.30%	Page 1 of 2		Page 2 Optional
Percent Fines	:	27.9%	Spec. Gravity	:	2.66 Assumed
	:		ERM Job No.	:	0283866

Physical Property Data

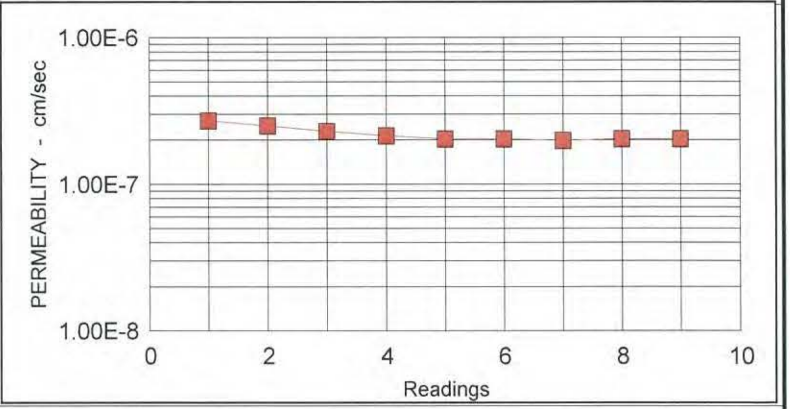
Initial Height (in)	:	4.16	Final Height (in)	:	4.13
Initial Diameter (in)	:	2.80	Final Diameter (in)	:	2.74
Initial Wet Weight (g)	:	771.00	Final Wet Weight (g)	:	752.67
Wet Density (pcf)	:	114.56	Wet Density (pcf)	:	117.64
Moisture Content %	:	36.14	Moisture Content %	:	32.90
Dry Density (pcf)	:	84.15	Dry Density (pcf)	:	88.52
Initial Void Ratio	:	0.9725	Final Void Ratio	:	0.8752
Saturation ,%	:	98.9	Saturation ,%	:	100.0

Test Parameters

Fluid	:	De-Aired Water	**Effective**		
Cell Pressure psi)	:	65.00	**Confining Pressure (psi)**	:	**10**
Head Water ɔsi)	:	56.80	Gradient	:	24.06
Tail Water ɔsi)	:	53.20			

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	3.90
Length, L	(in)	:	4.13
Area, A	(sqin)	:	5.90
Head, h	**(psi)**	:	**3.60**
Time, t	(min)	:	360.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K =	2.03E-007	(cm/sec) at 20 Degrees C
Average of Last 3 Readings	2.02E-007	cm/sec

SUMMARY OF FLEX WALL PERMEABILITY
TEST RESULTS
ASTM D-5084 (Method A)

JLT

Client	:	ERM	Print Date	:	07/18/2015
Project Location	:	Southern Premiere Edible Oils	Job No.	:	15LS3238.01
Sample Number	:	Mix CB-2 6% Dry	Tested By	:	TM / MLB
	:		Checked By	:	JBJr
As-Prepared M/C	:	48.20%	Page 1 of 2		Page 2 Optional
Percent Fines	:	29.9%	Spec. Gravity	:	2.66 Assumed
	:		ERM Job No.	:	0283866

Physical Property Data

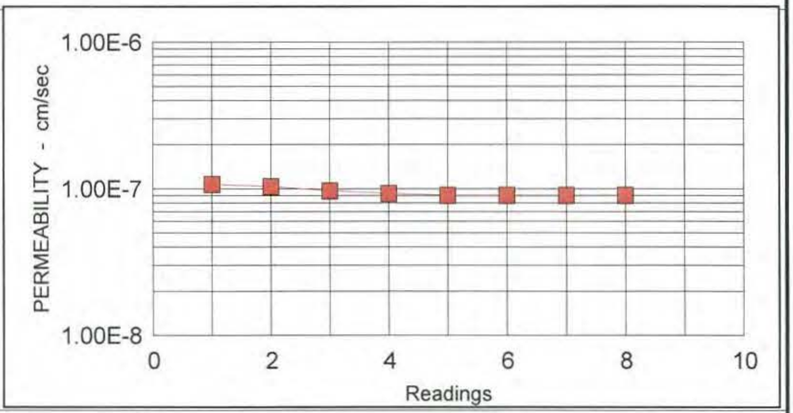
Initial Height (in)	:	4.22	Final Height (in)	:	4.15
Initial Diameter (in)	:	2.80	Final Diameter (in)	:	2.74
Initial Wet Weight (g)	:	768.90	Final Wet Weight (g)	:	749.29
Wet Density (pcf)	:	112.63	Wet Density (pcf)	:	116.55
Moisture Content %	:	37.84	Moisture Content %	:	34.32
Dry Density (pcf)	:	81.71	Dry Density (pcf)	:	86.77
Initial Void Ratio	:	1.0314	Final Void Ratio	:	0.9130
Saturation ,%	:	97.6	Saturation ,%	:	100.0

Test Parameters

Fluid	:	De-Aired Water	**Effective**		
Cell Pressure psi)	:	65.00	**Confining Pressure (psi)**	:	**10**
Head Water ›si)	:	56.80	Gradient	:	23.94
Tail Water ›si)	:	53.20			

Permeability Input Data
For Last Data Point

Flow, Q	(cc)	:	6.90
Length, L	(in)	:	4.15
Area, A	(sqin)	:	5.90
Head, h	**(psi)**	:	**3.60**
Time, t	(min)	:	1440.00
Temp, T	(Deg C)	:	18.7



Computed Permeability

PERMEABILITY, K =	9.04E-008	(cm/sec) at 20 Degrees C
Average of Last 3 Readings	9.03E-008	cm/sec

Attachment F
1200-C Permit

THIS PAGE INTENTIONALLY LEFT BLANK

Oregon
Kate Brown, Governor

Department of Environmental Quality
Northwest Region Office
700 NE Multnomah Street, Suite 600
Portland, OR 97232
(503) 229-5263
FAX (503) 229-6957
TTY (800) 736-2900

August 4, 2015

Ken Novack
MMGL Corporation
818 Stewart St Ste 700
Seattle, WA 98101

Re: Construction Storm Water Control Permit
EPA Number: ORR10E106
File Number: 124368
Site: Southern Premier Edible Oils Groundwater Source Control Measure Groundwater Barrier Wall
County: Multnomah

Dear Ken Novack:

The Oregon Department of Environmental Quality has received your application and fees and is approving coverage under the National Pollutant Discharge Elimination System 1200-C Construction Stormwater Discharge Permit. Please be aware that you will be assessed an annual fee for each additional year of construction activity as long as this permit is in effect.

This statewide Permit term is five years, beginning December 1, 2010, and expiring November 30, 2015, regardless of when you apply for coverage within the 5 year period.

Important Permit Provisions
Please review your 1200-C Permit copy carefully. For all projects the permit:

- prohibits visible or measurable quantities of sediments from leaving the construction site and entering directly into surface waters, or to conveyance systems that discharge to surface waters, and prohibits violations of the state's in-stream water quality standards. If this occurs, permit registrants are required to take corrective action to stop the discharge to surface water and submit a report outlining the corrective actions taken.
- requires permit registrants to implement a Sediment and Erosion Control Plan that meets new best management practices.
- requires daily inspections of erosion control measures when runoff is occurring.
- requires permit registrants to record all inspections and to keep all records up-to-date and on site.
- requires all erosion control measures remain in place through the duration of construction project.

For construction projects involving 5 acres or more:

- Permit applications and Erosion and Sediment Control Plans will be subject to a 14-day public review period.

For construction projects that discharge to 303(d) listed water bodies for turbidity (water clarity), or sedimentation, or to water bodies covered under state Total Maximum Daily Load pollution limits:

- Permit registrants must implement additional best management practices on the site to treat, control, or prevent sediment discharges to "impaired" water bodies.

Additional listed water body and affected river mile information is available at DEQs website at:
www.deq.state.or.us/WQ/assessment/assessment.htm

Legal Owner Responsibilities
If legal responsibility shifts to another party during project development, a Transfer Request form and fees must be submitted to DEQ to transfer the permit to the new responsible party.

Coverage Termination Process
Be sure to submit a Notice of Termination Request Form to the regional DEQ office when your construction activity is completed. If a Termination Request Form is not received by DEQ, **you will be billed** an annual fee for each additional year your permit remains in effect.

Permit coverage may be terminated when the following conditions are met:

- All construction activities authorized by this permit have been completed –
  - The site is stabilized, including landscaped with vegetation growing, and no exposed soil is present,
  - No further grading or soil disturbances occurring, and
  - Temporary erosion and/or sediment controls have been removed and properly disposed.

For complete details on termination, including termination for a common plan of development or sale, please see permit condition D.3.

Finally, this permit does not authorize excavation or fill in state waterways, including wetlands, and does not replace the requirement for receiving authorization to do this type of work under Section 404 of the Clean Water Act.

Please check the DEQ website at http://www.deq.state.or.us/wq/stormwater/stormwater.htm for forms or information. If you have any questions about this permit, please contact Ian Garner (503) 229-5438 in our Northwest Region Office or e-mail at garner.ian@deq.state.or.us.

Sincerely,

Ian Garner
DEQ NWR Water Quality Permit Coordinator

Enclosure
cc: File

GENERAL PERMIT
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
STORMWATER DISCHARGE PERMIT

Oregon Department of Environmental Quality
811 SW Sixth Avenue, Portland OR 97204
Telephone: (503) 229-5279 or 1-800-452-4011 (toll free in Oregon)

Issued pursuant to ORS 468B.050 and Section 402 of the Federal Clean Water Act

ISSUED TO: 8/4/2015	GEN12C	MULTNOMAH/NWR
File No.124368	ORR10E106	

MMGL Corporation
818 Stewart St Ste 700
Seattle, WA 98101

Site: Southern Premier Edible Oils Groundwater Source Control Measure Groundwater Barrier Wall

SOURCES COVERED BY THIS PERMIT:

- Construction activities including clearing, grading, excavation, materials or equipment staging and stockpiling that will disturb one or more acres and may discharge to surface waters or conveyance systems leading to surface waters of the state.
- Construction activities including clearing, grading, excavation, materials or equipment staging and stockpiling that will disturb less than one acre that are part of a common plan of development or sale if the larger common plan of development or sale will ultimately disturb one acre or more and may discharge to surface waters or conveyance systems leading to surface waters of the state.
- This permit also authorizes discharges from any other construction activity (including construction activity that disturbs less than one acre and is not part of a common plan of development or sale) designated by DEQ, where DEQ makes that designation based on the potential for contribution to an excursion of a water quality standard or for significant contribution of pollutants to waters of the state.

This permit does not authorize the following:

- In-water or riparian work, which is regulated by other programs and agencies including the Federal Clean Water Act Section 404 permit program, the Oregon Department of State Lands, the Oregon Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, the U.S. Army Corp of Engineers, the National Marine Fisheries Service, and the Department of Environmental Quality Section 401 certification program.
- Post-construction stormwater discharges that originate from the site after completion of construction activities and final stabilization.
- Discharges to underground injection control (UIC) systems.

Neil Mullane

Neil Mullane, Administrator
Water Quality Division

Effective: December 1, 2010
Expiration Date: November 30, 2015

PERMITTED ACTIVITIES

Until this permit expires, is modified or revoked, the permit registrant is authorized to construct, install, modify, or operate erosion and sediment control measures and stormwater treatment and control facilities, and to discharge stormwater and certain specified non-stormwater discharges to surface waters of the state or conveyance systems leading to surface waters of the state in conformance with all the requirements, limitations, and conditions set forth in the permit including attached schedules as follows:

Contents

Attachment G
Revised CMMP

THIS PAGE INTENTIONALLY LEFT BLANK

To:	Erin McDonnell, Oregon Department of Environmental Quality
From:	Brendan Robinson, ERM
Date:	September 2015
Subject:	Draft Contaminated Material Management Plan, Groundwater Source Control Measures, Premier Edible Oils (PEO), Portland, Oregon ERM PN 0283866

On behalf of MMGL, ERM-West, Inc. (ERM), has prepared this Draft Contaminated Materials Management Plan (CMMP) in support of the implementation of the Groundwater Source Control Measure (GW SCM) at the former Premier Edible Oils (PEO) facility located at 10400 North Burgard Way, Portland, Oregon (the "site").

This Draft CMMP is being submitted to the Oregon Department of Environmental Quality (ODEQ) on behalf of MMGL in support of the Groundwater Barrier Wall (GWBW) installation activities. The purpose of this document is to provide details on the handling and disposal of potentially contaminated material generated during the excavation and construction activities, including:

- Identification of potentially contaminated media;
- Soil excavation, handling, and screening;
- Sampling and testing requirements;
- Debris and other material handling and screening; and
- Transportation and offsite disposal.

IDENTIFICATION OF POTENTIALLY CONTAMINATED MEDIA

Waste materials are anticipated to be contaminated. In order to be comprehensive, this plan addresses the handling of all material to be excavated as part of the installation of the GWBW, regardless of the existence of contamination. All soil and debris excavated during the installation of the GW SCMs will be temporarily stockpiled on site until properly characterized and disposed of in accordance with all state and federal regulations at an appropriate off-site disposal facility.

Based on previous investigation's soil data, soil and debris from the excavation area will be considered to potentially contain elevated petroleum hydrocarbons, volatile organic compounds (VOCs), benzene, toluene, ethylbenzene and xylenes (BTEX), and polycyclic aromatic hydrocarbons (PAHs).

SOIL EXCAVATION, SCREENING, AND HANDLING

The contractor will be responsible for the proper handling of all excavated material generated during the course of construction. Soil, and possibly other debris, will be generated during the excavation. Handling and screening procedures outlined in this plan apply to all materials excavated during the GWBW construction. This section discusses the handling and screening of soil and the segregation and handling of debris and other material.

Monitoring and screening of the excavated soil will be conducted to allow for the segregation and handling of these materials. The soil and debris excavated will automatically be placed in a stockpile area within the contractor assembly and staging area for characterization. Soil and debris will be visually inspected for contamination, such as free product, dark staining, or odors.

Air monitoring will also be conducted during all excavation activities for health and safety purposes in accordance with the site health and safety plan, using a photo-ionization detector (PID) equipped with an 11.7 eV lamp and/or a flame ionization detector (FID). Each location of excavation of soil will be screened periodically using the PID and/or FID meter within 6 inches of the freshly excavated soil, or approximately every 30 minutes. Excavated soils will not be re-used on site, and excavated material will be considered potentially contaminated with VOCs and will be stockpiled for characterization and disposal. Excavated soils are not required to be segregated based on PID readings, given the small volume anticipated and given that it will not be re-used on site.

If the soil is temporarily staged adjacent to the excavation, the soil staging area will consist of a temporarily constructed, bermed area lined with plastic sheeting. The temporarily staged soil will also be covered with 6-mil low-density polyethylene (LDPE) sheeting at the end of each work day. Potential fugitive dust will be mitigated by ensuring that excavated soil remains covered or sufficiently moist until it is transported to the stockpile area as described in Specification Section 01430 – Environment Protection.

The soil in the stockpile area will be managed in accordance with 40 Code of Federal Regulations (CFR) 265.250, 265.251, and 265.253 through 265.260 (without the leachate collection system). No liquid wastes or free liquids will be placed in the stockpile area.

SAMPLING AND TESTING REQUIREMENTS

Prior to transportation and off-site disposal, a sample of the soils will be collected and analyzed using the toxicity characteristic leaching procedure (TCLP) test method. The potentially required sampling analyses, pending confirmation with appropriate waste disposal facility and all required guidelines, are as follows:

- Dissolved Organic Carbon (DOC) by Method SM 5310 C.
- Chloride by Method 300.0 and Nitrate + Nitrite as Nitrogen by Method 353.2.
- Organochlorine Pesticides by Environmental Protection Agency Method 8081.
- PCB Aroclors by Environmental Protection Agency Method 8082.
- Total Petroleum Hydrocarbons by Northwest Methods NWTPH-Gx and NWTPH-Dx.
- Volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method 8260B;
- Semivolatile organic compounds (SVOCs) by USEPA Method 8270B;
- PAHs by USEPA Method 8270; and
- Total Metals and Total Dissolved Metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag).

The results of these analyses will be compared to the criteria in Table 1 of the CFR Title 40 Part 261, and used to characterize the material and produce an appropriate waste profile. Based on the limited spatial variability of the anticipated material for disposal, a minimum of one sample will be required, pending confirmation with an appropriate waste disposal facility and required guidelines. The minimum sampling requirement may be increased based on actual spoil volume, conditions observed, and the disposal facility requirements. An appropriate disposal method and facility will be selected based on the waste profile.

DEBRIS AND OTHER MATERIAL SCREENING AND HANDLING

Excavated materials may include debris and other material. Examples of debris and other material include: concrete, asphalt, rebar, construction material, construction debris, demolition debris, and other non-soil materials. This section of the Draft CMMP addresses the screening and handling of these materials.

Debris and other excavated non-soil material will be visually/olfactorily inspected for contamination, such as free product, dark staining, attached soil, or odors. If this inspection indicates that the debris or other material is contaminated differently than the other debris and materials, then the debris will be stockpiled accordingly in separate areas.

Debris will be handled in the same manner as the excavated soils around the debris; however, debris may be segregated from excavated soil within the designated stockpile area. If the debris is temporarily staged adjacent to the excavation, the debris staging area will consist of a temporarily constructed, bermed area lined with plastic sheeting. Potential fugitive dust will be mitigated by ensuring that excavated debris or other materials remain covered or sufficiently moist until transported to the stockpile area, as described in Specification Section 01430 – Environment Protection. Debris and other materials that are suspected to be or identified as contaminated will be staged separately from other soil and debris.

TRANSPORTATION AND OFF SITE DISPOSAL

Materials may be transferred off site if MMGL, in consultation with DEQ, determines offsite transportation and disposal of some of the excavated or other materials (e.g., stockpile materials) encountered during GW SCMs construction is desirable. The following minimum requirements will apply to the transportation and offsite disposal of soil and debris.

The Contractor will be responsible for transportation of all materials to an appropriate off site disposal facility. A properly licensed waste hauler, depending on the type of waste, will be used to transport all waste materials. All loads will be covered prior to leaving the site. No waste will be permitted to leave the site unless it has been properly manifested, in accordance with all applicable regulations and disposal facility requirements.

Waste facilities that may be used for off-site disposal will be identified to MMGL and DEQ prior to commencement of the work. These facilities must be approved by MMGL and the DEQ Clean-up Project Manager. These facilities will meet the environmental, grading, safety and health requirements of the state, county, and local political subdivision where located. All disposal facilities will be legally licensed and permitted. Disposal facilities with significant RCRA violations or compliance problems (such as facilities known to be releasing hazardous constituents into groundwater, surface water, soil, or air) will not be used. The DEQ Clean-up Project Manager is to be contacted via phone or email to confirm approval of the off-site disposal facility prior to transportation.

Handling and Disposal of other Waste Streams. Other waste streams that may be generated during the GW SCM work include:

- Decontamination water
- Solid wastes
- Sanitary wastes

Each of these waste streams will be managed in accordance with applicable federal, state, and local regulations and as described below and in Specification Section 02250 – Transportation and Disposal of Materials.

To the extent possible, truck traffic will be restricted to paved areas of the site to minimize the need for equipment decontamination. Water generated from the cleaning of construction and excavation equipment and/or from the cleaning of debris that may be encountered during soil excavation will be containerized and stored on site. The containerized decontamination water will be sampled and disposed of off site in accordance with Specifications Section 01430 – Environmental Protection and Specification Section 02250 – Transportation and Disposal of Materials.

All solid waste, including waste paper, garbage, and other non-hazardous debris, will be bagged in plastic garbage bags and placed in a solid waste dumpster provided by the Contractor. The Contractor will be required to provide a sanitary portable restroom facility. Cleaning of the restroom and disposal of the restroom waste will be conducted by a licensed and bonded sanitary restroom provider and in accordance with a schedule that is based on the number of onsite workers. The sanitary restroom waste disposal and cleaning will occur at a minimum of once per week.

De-watering activities are not expected to occur and un-used groundwater or collected stormwater associated with construction activities will not be permitted to be discharged off site. Stormwater is expected to infiltrate on site. If groundwater is generated or stormwater is collected associated with construction activities, the liquids will be containerized on site. The containerized decontamination water will be sampled and disposed of off site in accordance with Specifications Section 01430 – Environmental Protection and Specification Section 02250 – Transportation and Disposal of Materials.

MAXIMUM ALLOWABLE CONCENTRATIONS OF IMPORTED FILL

Import fill material should be characterized to confirm it is "clean" and suitable for placement onsite. Results should be submitted to DEQ Cleanup Project Manager for review/approval prior to transport to the site.

One representative sample will be collected per 1000 cubic yard of imported soil. It should be noted that dense graded aggregate is not considered soil or suitable for testing.

The following constituents must be analyzed and confirmed below the "Clean Fill Values" noted in the DEQ *Clean Fill Determinations* date July 23, 2014:

- Volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method 8260B; and

- Total Metals (As, Ba, Cd, Cr, Pb, Hg, Se, Mn and Ag).

Additionally, the following constituents should be analyzed and confirmed 100 part per million (ppm):

- Total Petroleum Hydrocarbons by Northwest Methods NWTPH-Gx and NWTPH-Dx.

If analyzed concentrations exceeded the above state criteria, the concentrations should be compared to known concentrations of site soil and the DEQ Cleanup Project Manager contacted for approval.